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THE RELATION BETWEEN AGE, SLEEP, AND HEALTH IN SHIFTWORKING NURSES

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To my father and the loving memory of my two mothers

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SUMMARY

In this study, the relationship between age, sleep, and health in a group of shiftworking nurses was investigated. The study forms part of a larger study into the health and well-being of shiftworking nurses and midwives in England and Wales (Department of Health, 1993).

First the importance of the relation between age and sleep was considered. Next, the impact of two important moderating variables, shiftwork and gender (roles), was examined. The nurses worked two very different shift systems: permanent night shifts or rotating shifts. The gender distribution in the sample was very skewed, which resulted in the inclusion of gender roles as variables.

Having established the relative importance of the three variables, the next step was to investigate effects of the relation between the variables. Reduced alertness was the most important acute effect considered. Health and well-being complaints were considered as the main chronic effects.

It was concluded that age has an important impact on sleep. The results however contradicted the dominant view in the literature that with age sleep always deteriorates. It was important to distinguish between sleep quantity and sleep quality. Both shiftwork and gender (roles) moderated the negative impact of age. Alertness was affected in a counterintuitive manner: older nurses reported feeling more alert compared to younger nurses. With regard to health and well-being, again results were surprising: health and well-being appeared to be more affected by reported sleep quality than by sleep duration.

The results from this study were more varied and less linear than could have been assumed on the basis of the literature. It is argued that research should beware of unjust generalisations and move away from simple dichotomies and allow for a more varied and colourful picture.

1

INTRODUCTION

1.1. The beginning

It all started with one of my advisers, and then head of the Shiftwork Research Team, Simon Folkard, pointing my attention to a paper written by Kripke et al. (1979). The paper, which is frequently quoted in the literature, reported on a longitudinal study of the relationship between sleep and mortality. In this paper, Simon had noticed a graph which showed a dramatic increase in sleep complaints for women over the age of 40 (fig. 2, p. 106): it looked like the sleep complaints doubled. It is a well-known fact that women report more insomnia, irrespective of age (Mauri 1990), but this age-related increase raised questions about gender, ageing and sleep.

Through my work with the Shiftwork Research Team in Sheffield, I had begun to become increasingly interested in circadian rhythm aspects of shiftwork, more specifically in sleep and sleep-related issues, such as sleepiness and fatigue. Gender and gender roles had already been the focus of a literature study I did when I was studying psychology at the University of Amsterdam. This literature study dealt with the issues of double burden and role juggling.

The study I was involved with in Sheffield, was a large study into the effects of shiftwork on the health and well being of nurses and midwives in

England and Wales. This study was commissioned by the Department of Health and conducted over a period of three years (1990-1993) by the Shiftwork Research Team, based in Sheffield. The data presented in this thesis were collected as part of this larger study. A full report of the study can be found in "Night and Shiftwork in Nursing and Midwifery, final report on a research programme commissioned by the Department of Health" (File number 195/0324). Use of the data for the purpose of this thesis has been negotiated within the team.

The study of nurses and midwives inevitably had a larger proportion of women in the sample and thus a focus towards possible gender related aspects of the effects of shiftwork on the health and well being of the worker seemed apparent. Add to this the fact that sleep is the most prominent complaint of shiftworkers, and the fact that a large proportion of the nurses in this study is older (i.e. the nurses who work a permanent night shift) and the subject of this thesis seemed almost self-evident. Nevertheless, some discussion and negotiation took place before the subject of this thesis was decided upon. During this process, Paula Nicolson, specialised in the area of gender issues, joined Simon as my second adviser. Recent developments in the area of shiftwork, gender and age, as described in paragraph 1.2. influenced the final domain of the thesis. Combining sleep, age, and gender within the context of this shiftwork study, the focus of the thesis became to explore the relationship between age and sleep in a group of, mostly female, shiftworkers.

In this introductory chapter, first a brief impression of the area under study will be given, together with the aim of the study. This will be followed by a short description of the study of which this thesis forms a smaller part. Finally, an outline of the chapters will be given.

1.2. Domain and aim of the thesis

1.2.1 Domain

For this thesis, a sample of shiftworkers were studied. Shiftwork can be defined as a system of working, in which a regular change of one group of workers for another takes place on the same type of job, and in the same workplace (Kogi 1985). Operating hours of an organisation using shiftwork extend beyond the usual 9-5 work routine. The total period of time covered can be either continuous for 24 hours, or discontinuous for less than 24 hours per day, or for less than 7 days per week. The most frequently encountered form of around the clock shiftwork is a three shift system: the 24 hour day is divided into three shifts: a morning, evening and night shift. These three shifts can be worked in a sequence, this is called rotating shiftwork. Another option is that a worker only works one of the three shifts, then the term permanent night (or morning or evening) shiftwork is used. Whatever the system worked, shiftwork habitually requires the worker to work and rest at unusual times. This results in impaired and truncated sleep. Both sleep quality and sleep quantity (or duration) are affected by shiftwork. Research has shown that in the long run, shiftwork may result in health complaints. It is assumed that the affected sleep of shiftworkers contributes to the occurrence of health problems.

With regard to women in shiftwork, evidence has been found that they report more sleep difficulties compared to men in shiftwork. Women who care for younger children report most difficulties and also shorter sleep duration compared to both women without children who work shifts, and male shiftworkers (Gadbois 1981). And with childcare facilities not always readily available or preferable, it should come as no surprise that women with childcare responsibilities sometimes choose shiftwork as a means to combine work and childcare responsibilities. However, according to research, they are the most vulnerable group where sleep duration is considered. Furthermore, as described above, with age, reported sleep problems of women increase more than those of men.

Within this context two recent developments are important. First, shiftwork has become more accessible to women due to changes in the law with regard to night work. Second, the composition of the work force is changing. It is anticipated that the work force in the Western world, is likely to become older and will have an increased participation of women (Scott & LaDou 1990).

Together, these issues draw attention to the relationship between age and sleep in women in shiftwork. Different aspects of this relationship have been studied, e.g. sleep and age, shiftwork and gender, and shiftwork and sleep. However, to our knowledge, attention has never been paid to the combination of all four aspects. Nor has the subsequent impact on health been considered, which is the focus of this thesis.

1.2.2. Scope

The focus of the thesis is confined by the data of the Department of Health study. Before discussing the aim and research questions of this thesis, some limitations need to be pointed out. First of all, we are dealing with a survey study. Data collected reflect self-reported information. For example, sleep difficulties and sleep duration were self-reported. So called more objective measures, such as polysomnographic recordings, are not available. Likewise, no physiological data are available to consider differences between the social or biological nature of results in more detail. While writing the thesis, it did strike me however that a lot of the problems discussed in this thesis have both biological and social roots. At several points in this thesis, the relative impact of both factors is taken into consideration. It should be noted that this reflects a way of grouping, both factors are not mutually exclusive and are certainly interrelated.

Second, the study deals with a sample of shiftworkers. No comparisons can be made with day-workers, no other control groups are available. And finally, with regard to age, it needs to be pointed out that the sample consist of people who are still in employment, and who will thus not be older than 60-65. The mean age in the sample studied was 33, with a standard deviation of 9.5

years. Most ageing studies include older age groups. The results from this study regarding the effects of age need to be considered with this limitation in mind.

1.2.3. Aim

The aim of the thesis is to explore the relationship between age and sleep in a group of, mostly, women in shiftwork. In addition, a temporal ordering of the main variables, to describe the relationship between age, sleep, and health effects will be analysed. This temporal ordering is based on the theoretical model underlying the SSI (Folkard 1993, Barton et al. 1995). The following research questions are considered:

1. Is there evidence of an age-related effect on sleep duration and sleep difficulties?
2. Is there evidence of an impact of shiftwork and of gender on the relationship between age and sleep.
3. Is there evidence of an effect on health and well being of the relationship between age, sleep, shiftwork and gender.

1.3. The study

In this paragraph, only a brief description of the study and the sample will be given. A more extensive description can be found in appendices I and II. In appendix I, the measures used in this study are described. In appendix II, more information can be found on the sample of the study.

1.3.1 Data collection

The project started with a classification of shift systems in use in general hospitals in England and Wales (Barton et al. 1993). On the basis of this classification, data was collected from a random sample of nurses covering the classification criteria: flexibility of the shift system and night shift coverage. A description of the sample, including response rate information and information and representativity, can be found in appendix II.

Survey data collection took place in two stages. For stage one, a new questionnaire, the Standard Shiftwork Index (SSI) was developed. Second, nurses who volunteered to participate in further studies were sent a follow-up questionnaire, six months after completing the SSI.

1.3.2. Measures

The nurses completed two questionnaires: The Standard Shiftwork Index (SSI, Barton et al. 1995, Folkard et al. 1993), and a Follow-up Questionnaire. Both questionnaires are included respectively as appendix III and appendix IV.

The SSI was developed for the purpose of the larger study mentioned above and contains a large number of measures which look at problems associated with working shifts. The purpose of the questionnaire in this study was to evaluate the impact of different types of shift systems, and features of shift systems, on the health and well-being of the individual nurses and midwives concerned. The scales selected for the SSI can be classified under the following headings: first, 'outcomes', relating to the actual problems experienced by the individuals concerned; second 'moderators', relating to those differences between individuals which may serve to moderate the impact of shiftwork; and third 'general', including specific details of the features of the shift system, together with questions about the work context and biographical details. For this thesis health measures, sleep measures and biographical details such as age, gender, number of children at home that needed to be looked after by the shiftworker, and reasons for working shifts, were relevant.

The purpose of the follow-up questionnaire was mainly to enable members of the Research Team to pursue some of their own research interests. This is reflected in the variety of measures that were included. Measures relevant to this thesis were alertness ratings and a scale measuring work-nonwork conflict.

1.3.3. The sample

The SSI was sent to 4000 nurses. 375 questionnaires could not be distributed and were returned. A total number of 1532 completed questionnaires was returned, giving a response rate of 42.3%. The sample spanned 101 different general hospitals throughout the 14 health regions of England, and throughout Wales. Hospitals were selected for inclusion in the study on the basis of size, that is, 400 or more beds. Thus, with the exception of smaller hospitals, the sample can be considered representative. The number of questionnaires sent to each hospital varied, and was largely determined by the frequency with which other hospitals operated the same type of shift system. Thus if a relatively common system was in operation, fewer questionnaires were sent in order to spread the distribution across the country (Barton et al. 1995).

The Follow-up Questionnaire was sent to 904 nurses who volunteered to complete more measures. Of these, 648 nurses returned completed questionnaires, giving a response rate of 72%. The mean age of the nurses in the SSI sample was 33 years (s.d. 9.5 years). The vast majority were women and two-thirds of the sample were married. Just over 60% of the nurses did not have dependants at home. On average, the nurses had worked shifts for almost 12 years (s.d. 7.4) and a small majority worked rotating shifts (57%) and not permanent night shifts (42.6%). The average number of hours worked per week was 34 (s.d. 7.2). And in the total sample, domestic reasons were not the prime motivation to work shifts. Sleep duration was shortest on night shifts (mean 6.88, s.d. 1.57) and longest on afternoon shifts (mean 9.24, s.d. 1.30). Sleep difficulties scores were highest for the night shift (mean 19.07, s.d. 5.1) and lowest for the sleeps on rest days (mean 13.12, s.d. 1.2). The following shift times were worked by the vast majority of nurses: morning shift from 07:30-15:30, afternoon shift from 13:30-21:30, and night shift from 21:00-08:00. A more complete description of the sample and various subsamples can be found in appendix II.

1.4. Structure of the thesis

The structure of this thesis, apparently, is different from the structure of most theses. Generally, a thesis first gives a full literature review, followed by analyses and general discussion. Here, literature and analyses are combined per chapter. In this way, it is thought that an idea for an ordering in time is developed in a more natural way. It is hoped that this structure will also make it easier for the reader to follow the line of reasoning of this thesis.

By now it will be clear that this study dealt with a shiftworking population. Nevertheless, chapter 2 only deals with the relationship between sleep and age. Before age related problems in relation to sleep can be investigated, the relationship between age and sleep needs to be established. This is the focus of chapter 2. What can be said about the relationship between age and sleep? Is there a different effect of age on sleep duration and reported sleep difficulties or not? And does sleep need change with age?

Chapters 3 and 4 deal with two factors that are likely to influence the relationship between sleep and age: shiftwork and gender. Chapter 3 considers the impact of shiftwork on the relationship between age and sleep. How does shiftwork affect the sleep duration and sleep difficulties of the worker? Do older shiftworkers experience more or less sleep problems or different sleep problems? In chapter 4, gender differences are considered. Do men and women report the same changes in sleep in relation to age? What are possible sources of sleep problems in women? Is the sleep of women in shiftwork different to the sleep of men in shiftwork? And how do older female shiftworkers compare to older male shiftworkers, or to younger female shiftworkers.

In chapters 5 and 6, attention will turn to the effect on health and well-being of the relationship found between age, sleep, shiftwork and gender. Chapter 5 deals with an important acute effect of sleep problems: sleepiness or reduced alertness. Do reported sleep difficulties or reduced sleep duration affect the reported alertness of shiftworkers? Does age affect this relationship? And what are possible explanations for the results reported? In chapter 6, more chronic effects of the relationship between age and sleep are considered. How does this relationship affect the health and well-being of female shiftworkers? And do older women in shiftwork with more sleep complaints and shorter sleep duration report most health complaints?

In this way a temporal ordering will be developed, analogous to the theoretical model underlying the SSI (see below), similar to the ordering reported by Barton et al. (1995). Support from the data for this ordering will be investigated. The central assumption is that ageing affects sleep. This relationship is moderated by shiftwork and gender role aspects. Sleep difficulties and reduced sleep duration subsequently lead to, first, acute problems and then more chronic health problems. Frequently, sleep difficulties have been seen as an outcome measure of shiftwork. In this ordering, sleep difficulties are seen as preceding health problems. It is assumed that prolonged sleep difficulties and reduced sleep duration contribute to reduced alertness and to health problems.

At the end of chapter 6 this ordering is tested. And finally, all results and their relevance will be discussed in chapter 7.

Figure 1.1:
Proposed ordering in time

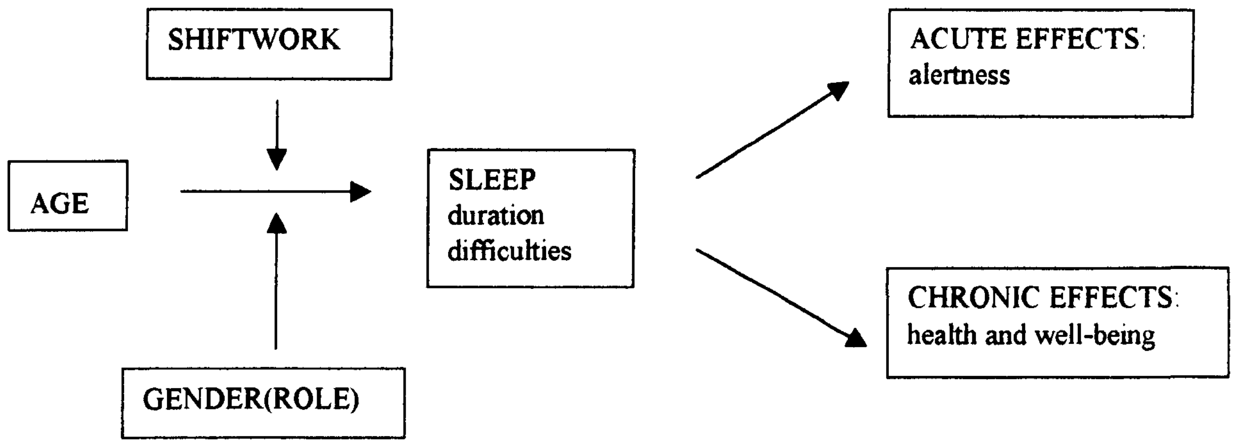
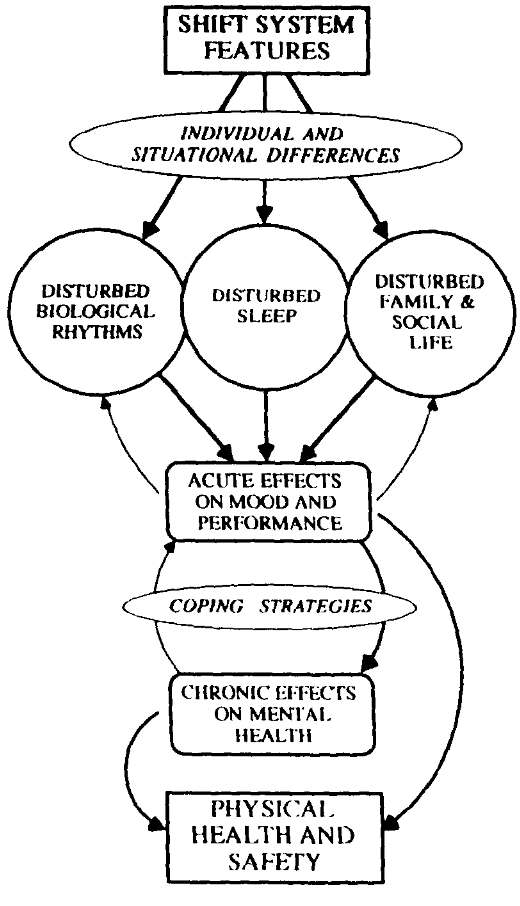


Figure 1.2:

Theoretical model on which the Standard Shiftwork Index (SSI) was based (Barton et al. 1995, Folkard et al. 1993). Folkard 1993. Reprinted with permission.



2

AGE AND SLEEP

2.1. Introduction

The first step in exploring the relationship between sleep, age gender and shiftwork will be to look at the relationship between sleep and age, as the two prime variables. In this chapter attention will be paid to the phenomenon of sleep and to the relationship between sleep and age. First, a summary of different aspects of sleep will be given. Then attention will focus on the relationship between age and sleep: how sleep patterns change with age and what might be the cause of such changes. In the analysis section of this chapter, attention will concentrate on sleep and its relationship to age in this particular sample.

2.2. Sleep

Much has been said and written about sleep. Ideas and theories about the process and function of sleep are very old. More scientific research into the why and how of sleep, however, is not very old. The main reason being that sleep was always considered to be a rather inaccessible phenomenon. For scientists, sleep became more accessible with the discovery of the Electroencephalogram (EEG) in 1920. The EEG records brain waves of approximately ten cycles per second, know as alpha waves. The EEG, together with the Electrooculogram (EOG) to record eye movement and the Electromyogram (EMG), which records muscle tension have provided us over the last 70 years with important information about the profile of our sleep. It has led to the discovery of Rapid Eye Movement (REM) sleep and to the establishment of the different stages of sleep or the sleep profile. Four stages of sleep plus REM sleep together form this sleep profile (Borbély 1987).

2.2.1. The sleep profile

Stage 1 is a transitional phase between waking and sleeping, also known as the falling asleep stage. The alpha waves give way to small, rapid and irregular waves, while the EOG registers rolling movement of the eye. Stage 2 follows shortly after falling asleep and marks the actual onset of sleep. Slightly larger waves appear, overlapping with bursts of rapid waves called sleep spindles. Occasionally, large, slow waves appear. Muscle tension is significantly lower than in the waking stage and the eyes are quiet. After a few minutes the EEG waves become still larger (i.e. of higher amplitude) and slower, marking the start of stage 3. These slow oscillations are called delta waves. If they occupy between 20 to 50 percent of the recording time, it is called stage 3. Stage 4 has been reached when the oscillations represent more than 50 percent of the recording time. Stages 3 and 4 are considered to constitute "delta sleep" or deep sleep and are also known as "slow wave sleep" (SWS). After some twenty minutes in stage 4, the subject is likely to move. This body movement becomes more infrequent as sleep becomes progressively deeper but occurs often at the end of a period of deep sleep. The brief episode of body movement is followed by stage 2 sleep. Rapid eye movement announces the arrival of the first period of REM sleep, some sixty minutes after falling asleep. The first period of REM sleep lasts only a few minutes and is followed by, again, stage 2 sleep. REM sleep is fundamentally different from non-REM sleep (i.e. stages 1 to 4) and is also known as paradoxical sleep. The reason for this is that the EEG during REM sleep resembles that of stage 1 even though the sleep is deep. REM-sleep and non-REM sleep follow each other in a cyclical pattern. After a period of REM-sleep, stage 2, 3 and 4 sleep and again stage 2 sleep will follow before the next period of REM-sleep. Four to five of such cycles can be distinguished in a full night's sleep. Each cycle lasts about ninety minutes. In the course of the night's sleep, deep sleep occurs less and less, with the reverse being true for REM-sleep periods which increase in length with each cycle. For every individual, a large period of REM sleep is spent dreaming, but dreams can also occur during other sleep stages. (Morin 1993, Borbély 1987).

2.2.2. The sleep-wake cycle: the importance of circadian rhythms

Even if human beings were completely free to choose the times at which to go to bed and wake up, they would still largely sleep at night and be awake during the day. This is caused by a system of periodic environmental changes. For our sleep the most important rhythm is the 24h light/dark cycle. In addition, the influence of these periodic environmental changes is mediated by regular cyclic variations in bodily processes, our biological rhythms. Rhythms can be grouped according to the time it takes them to complete a cycle. Some rhythms have a cycle of less than 24 hours, such as the sleep stages. They are called ultradian rhythms. Some rhythms have a cycle of well over 24 hours, such as the menstrual cycle. They are known as infradian rhythms. Other rhythms have a cycle of about 24 hours, they are called circadian rhythms. In human beings, the most pronounced of these biological rhythms are the circadian rhythms. Examples are body temperature and blood pressure. The circadian rhythms can be described in terms of three main characteristics:

(i) their *period*, which is the time to complete one cycle of the rhythm and is always about 24h in the case of circadian rhythms,

(ii) their *phase*, which is a measure of their timing with respect to some external criterion such as clock time, and is normally described by when a peak value (or acrophase) is found, and

(iii) their *amplitude*, which is usually taken as the difference between this maximum value and the average value (*mesor*) over a complete cycle of the rhythm (Folkard 1996a, Minors & Waterhouse 1981, Moore-Ede et al. 1982).

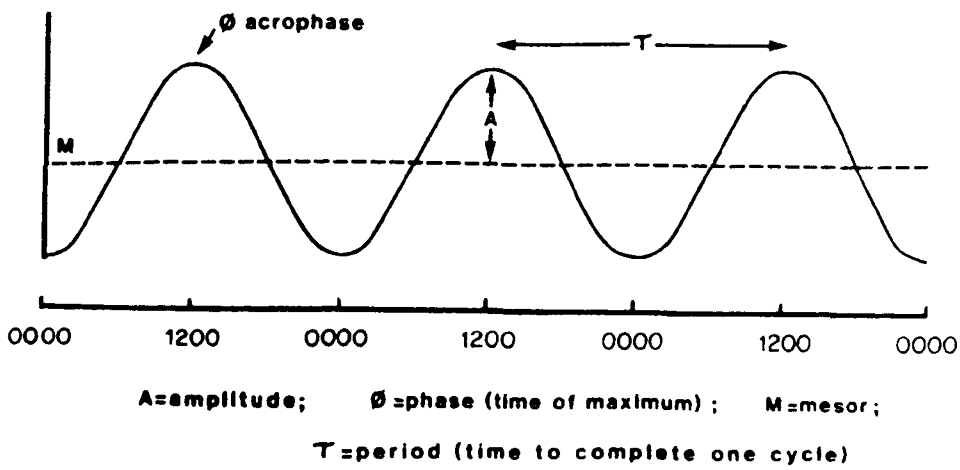


Figure 2.1: Fitted cosinor curve, indicating the acrophase, mesor, amplitude and period.
Folkard and Monk 1985. Reprinted with permission.

A large number of bodily functions follow this 24 hours rhythm. Body temperature is one example. Body temperature has a peak in the evening (round 20.00) and a trough in the early morning (round 04.00). Other examples are brain function, heart rate, cortisol levels, and melatonin secretion. Although not all rhythms have the same peak and trough times, they are internally connected and synchronised to help regulate a 24 hour cycle.

Through these rhythms our body is geared towards being active during the day and being passive at night and as such they influence our sleep-wake cycle in that they make it easier for us to sleep at night and be awake during the day. For example, the trough in our body rhythm at 04.00 explains why it is very difficult to wake up at this time (Minors & Waterhouse 1985). Likewise, most people would not find it easy to have to sleep during the day (Borbély 1987). People's ability to fall asleep, or their 'sleep propensity', at different times of day has been examined in a number of studies under normal conditions. Sleep propensity has been found to be typically high at night and lower during the day. In addition, evidence has also been found for a secondary increase in sleep propensity which corresponds to the often called 'post-lunch dip' in performance (Folkard 1996a).

Body clock and zeitgeber

Biological rhythms are controlled by an endogenous and an exogenous system. The endogenous system is called the body clock. The exogenous system refers to zeitgeber ('time givers'), which are environmental time cues. Our circadian rhythms are controlled by the body clock which regulates them into a cycle of approximately 24 hours with the aid of the zeitgeber. Under normal circumstances the measured or 'overt' circadian rhythm in any given variable will reflect the combined influence of both the endogenous (i.e. body clock) and exogenous (or 'masking') processes (Folkard 1996a).

Process 'S' and Process 'C'

According to Borbély (1987), there are two processes that determine when and how easily we will fall asleep. Process 'S' is also known as sleep propensity, or ability to fall asleep. This function will start to rise from the moment we wake up until the moment we fall asleep again. Process 'C' is a circadian component with a 24 hour cycle and a peak in the evening. When both processes are high (usually in the evening) one is most likely to fall asleep.

Disturbance of rhythms

Studies in which individuals have lived isolated from external cues for a limited period of time have shown that without the zeitgeber, which are found in the external environment of the individual, the body clock regulated our body rhythms in a cycle of 25 hours, which is called the free running rhythm. Time isolation studies have also shown that individuals seldom fall asleep when their body temperature is rising, despite the fact that their environmental conditions are constant. As a result of this, their sleep duration varied depending on the phases of the endogenous component of their temperature rhythm at which they fall asleep (Folkard 1996a).

One of the important aspects of these studies is that they have pointed to the combined control function of the endogenous and exogenous systems. It is important to note that a fine balance between the two regulates our 24 hour rhythm and as such influences our sleep/wake cycle. The balance can be disturbed as is shown in time isolation experiments, when external time cues are eliminated and the rhythms start to follow a 25 hour rhythm, following feedback from the endogenous system: the internal biological clock. In this situation, the rhythms are still internally synchronised.

Another situation is when the rhythms receive conflicting information from both systems. The most commonly experienced example is jet-lag. Here, a person changes time-zone and the body clock will receive modified information about the time of day through the zeitgeber. This can severely disrupt the normal sleeping pattern, with people waking up in the middle of the night (related to the 'new' clock time) and falling asleep in the middle of the day. The external time cues give information on a different time in the cycle compared to the internal body clock. The rhythms then start to desynchronise as a result of the conflicting information. If the external information remains consistently different, the circadian system will start to realign and adjust to the new situation. And when one, as often happens in the case of jet-lag, returns to the original destination, realignment will again be needed. This change process is a slow process. The extent to which the system needs to realign will depend on how adjusted the system has got to the previous situation. The change process is not only slow, time-isolation studies have shown time and again that there is seldom a complete reversal of rhythms. At best rhythms flatten and re-align to a certain degree (Åkerstedt 1985, Minors & Waterhouse 1985, Monk 1991).

The extent to which circadian rhythms adjust, varies and appears to depend to a large extent on their degree of control by exogenous factors. Rhythms with a large exogenous component, such as heart rate and blood pressure, have typically been found to show rather greater adjustment than those in more endogenously controlled variables such as body temperature, and adrenalin (Folkard 1996a).

Another situation which causes disturbance of circadian rhythms is shiftwork where conflicting information is received about the time of day, for example having to go to sleep when the sun shines and day-time noises and activities can be heard and observed. This will be dealt with in detail in the next chapter.

Morning/Evening types

In circadian rhythms research possible sources of variation between individuals have been considered. Differences caused by age and gender have been studied. With age, amplitude reductions of rhythms have been found. Gender differences have been less consistently reported. Both variables will be discussed in more detail in subsequent chapters.

For the sleep-wake cycle another source of individual variation is relevant: the concept of morning and evening types, or 'larks' and 'owls'. This source of individual variation has received attention in many studies (Horne & Ostberg 1976, Kecklund et al. 1998, Kerkhof 1985, Webb & Bonnet 1978). In circadian rhythm terms: morning type people are characterised by a relatively advanced sleep-wake rhythm and evening types by a relatively delayed sleep-wake rhythm. With the use of self-assessment morningness scales, clear phase differences in the normal temperature rhythm of extreme scorers on these scales were established. Differences of up to two hours were found, with an average of 80 minutes. There is some evidence that evening types may show greater circadian adjustment than morning types. The general pattern appears to be that morning types show little, if any circadian adjustment, while evening types may delay the phase of their temperature rhythm by up to one hour per day.

With regard to sleep, morning types find it easier to get up early and evening types find it easier to stay up late. On average morning types go to bed 80 minutes earlier than evening types and arise in the morning 80 minutes earlier than evening types. Another difference is that morning types have been found to sleep the same number of hours each night and enjoy a less problematic, more satisfying sleep than do evening types (Webb & Bonnet 1978).

Finally, it has been reported that, with advancing age, people become more morning type. Therefore for this study, it seems relevant to consider morning-evening type differences in the sample in relation to sleep. (Folkard 1996a, Kerkhof 1985, Webb & Bonnet 1978).

2.2.3. *The function of sleep*

In the previous paragraph, attention has been given to the importance of circadian rhythms in regulating our sleep-wake cycle. It has been shown that circadian rhythm disturbance is a potential source of disruption of the sleep-wake cycle. This focuses attention to another important aspect of sleep to be considered: the function of sleep. Without some understanding of the function of sleep, it seems difficult to establish the importance of sleep disturbance. Looking at the function of sleep could provide insight into what the possible consequences of sleep disturbance are. The most frequently quoted function of sleep is recovery. Sleep is thought to be an active rather than a passive process and is supposed to have restorative and recuperative power (Borbély 1987). Sleep exerts a beneficial influence on physical as well as mental health, the precise nature of which is unknown. Horne (1985), for example, assumed that human sleep is governed by at least two mechanisms. One is an obligatory requirement probably for tissue repair and restitution (geared towards the brain) following the wear and tear of wakefulness. The other is a more facilitatory (facultative) sleep mechanism mostly under the influence of a sleep drive governed by circadian influences as well as behaviour such as boredom and habit. In general, people sleep between 7 and 8 hours per night and often longer during weekends (Carskadon & Dement 1985).

2.2.4. Effects of reduced sleep

The assumption that sleep is important for recovery has resulted in questions about the effects of lack of sleep or reduced sleep. The most impressive result to date is that epidemiological studies have suggested that a shorter average sleep length is associated with a shorter life span (Kripke et al. 1979, Diest et al. 1989). In a longitudinal study of more than a million American adults, Kripke et al. found that both sleeping too long and sleeping too short were associated with increased mortality. Too long was defined as more than 10 hours, too short as less than 4 hours. Men who reported usually sleeping less than 4 hours were 2.80 times as likely to have died within 6 years as men who reported 7.0 to 7.9 hours of sleep. The ratio for women was 1.48. Men and women who reported sleeping 10 hours or more had about 1.8 times the mortality of those who reported 7.0 to 7.9 hours of sleep. Causes of death in both groups were similar. Although sleep length in this study could have been influenced by early stages of illness or more external factors such as stress, it is still remarkable that this would lead to both a shortening and a lengthening of sleep.

2.2.5. Sleep deprivation studies

The potential effects of sleep loss have mainly been investigated in sleep deprivation studies. There is extensive evidence in the literature (and in our own lives for that matter) of the acute effect of sleep loss on daily functioning. An often used method to look at the function of sleep is by means of sleep depriving individuals for shorter or longer periods of time. Three types of studies are conducted: total sleep deprivation, partial sleep deprivation (i.e. reduced sleep), or selective sleep deprivation (i.e. a subject is deprived of certain sleep stages or of REM sleep). Horne (1988) for example, demonstrated that only one night of sleep loss can affect what he calls divergent or creative thinking. General, and more or less immediate, effects of sleep deprivation are: irritability, mood swings, fatigue, sleepiness, lack of concentration. This is followed by disturbances of perception in a more advanced stage when the borderline between sleeping and waking has become blurred and so-called microsleeps (of one to three seconds, in a later stages up to 6 seconds) start to occur (Borbély 1987).

Next to looking at the effects of accumulated sleep loss by keeping people awake for up to a number of days, sleep deprivation studies have also addressed the question of the average amount of sleep we need. In a study by Johnson and MacLeod (1973), subjects were asked to gradually limit their sleep to five and a half hours or less by going to bed half an hour later every two to three weeks, to stay at this level for a month and then to further reduce their sleep by a further 30 minutes for the next two months. For the last six months, subjects were free to chose how long they wanted to sleep. The study showed that subjects who used to sleep 8 hours maintained a reduced sleep level of on average 6.4 hours per night. Although their performance levels, measured with various tasks, were not affected, subjects did feel tired. Overtiredness was the main reason to stop further reduction of sleep. A study by Carskadon and Dement (1985) showed that a reduction of sleep hours to five increased subjects' sleep propensity during the day.

Sleep deprivation studies do not only enable researchers to study the effects of lack of sleep on the functioning of the individual. Also, the content and the nature of the recovery sleep, following sleep deprivation, can be studied.

In most cases, a single sleep period is often enough to remove all traces of sleep related psychological disturbances and performance deficits caused by the cumulative sleep deficit. Results from sleep deprivation experiments show that recovery sleep has an increased percentage of deep sleep. A rise in REM sleep is less pronounced and is often more likely to occur in a second recovery sleep period. Experiments suggest that different mechanisms regulate deep sleep and REM sleep. Deep sleep percentages rise immediately and already after short periods of sleep deprivation, REM sleep levels change only after a longer period of sleep deprivation and often not until the second recovery sleep period. These findings are confirmed by studies which did not look at total sleep deprivation but only at reduced sleep lengths. Deep sleep increases at the expense of Stage 2 sleep and REM sleep periods become shorter. A study in which a subject was only deprived of REM sleep showed that when REM sleep periods were stopped by awakening the subject when REM sleep periods started, they started to occur more frequently during the course of the night, i.e. REM sleep deprivation seemed to result in an immediate increased pressure for REM sleep. However, the belief that deprivation of REM sleep causes psychological disturbances because of its association with dreams is, according to Borbély (1987), a mistaken belief and is not backed by scientific research. Deprivation of other stages is also possible, but not of all non-REM sleep as this comprises 75-80 percent of total sleep and would result in almost total sleep deprivation.

As a sideline it can be mentioned that a remarkable 'use' of sleep deprivation is as a therapy for depression. Sleep disturbances are often an early symptom of depressive illness: sleep is superficial and interrupted at night, and early morning insomnia is also found. In this therapy, patients are kept awake for a period of time, depending on the seriousness of the symptoms. This leads to mood improvements for approximately 40 percent of the patients. However, the results were short-lived and relapse often already occurred after a first episode of sleep (Borbély 1987).

Although studies into sleep deprivation provide us with important information on more immediate effects of sleep deprivation on performance and the nature of recovery sleep, an important drawback of most sleep deprivation studies is that they often only consider the effects of short spells of sleep deprivation. This reduces the generalisability of their results with regard to the longer term effects on health performance and well-being of more chronic or persistent situations of sleep difficulties, such as in the situation of shiftworkers or of people suffering from chronic insomnia (Naitoh et al. 1990). In addition, it is noteworthy to observe that the function of sleep is frequently considered in relation to sleep *duration*. This seems reasonable: recovery takes time and therefore time asleep would be the obvious factor to study. More and more has research shown that, next to sleep duration, self reported sleep *difficulties* need also be studied in order to fully understand the consequences of disrupted sleep.

2.2.6. Sleep difficulties

Epidemiological studies indicate that between 10% and 15% of all people living in industrialised countries have serious sleep problems (Kaye et al. 1983). A distinction needs to be made between serious sleep problems and incidental sleep problems. Almost everybody experiences the occasional one or two bad nights' sleep, which is not a cause for concern.

Serious insomnia complaints can be categorised into two categories: difficulty falling asleep and difficulty staying asleep which includes both interrupted sleep and waking up too early. Another sleep problem is hypersomnia, when people find it difficult to stay awake during the day. General causes of disturbed sleep are varied: worries, excitement, illness, pain, breathing difficulties, and environmental influences, e.g. noise. Also, conditions before bedtime can influence sleep: strenuous activity, heavy meals, alcohol, coffee, nicotine. In many surveys into sleep difficulties, variation in sleep difficulties was associated with age and gender. Sleep disorders were more prevalent among women than among men irrespective of age, and, sleep disorders became more frequent with age (Borbély 1987).

Sleep duration and sleep difficulties

The relationship between sleep difficulties and sleep duration is a complicated relation, and conflicting results have been reported. Intuitively, the relationships seems simple: not enough sleep (a reduced sleep duration) should lead to a higher level of sleep difficulties. And enough sleep should be associated with fewer sleep difficulties. However, the relationship between these two variables was described as notoriously complicated and not always strong by some authors (e.g. Borbély 1987), where other authors assumed and found a strong link between the two (e.g. Escriba et al. 1992).

When investigating sleep difficulties in a sleep laboratory 'objective' recordings of sleep are made. With these recordings, it has been shown that people tended to overestimate the time it took them to fall asleep and underestimated the time they had actually been asleep during the night. These results have supported the idea that people in general overestimate the magnitude of their sleep problems. However, Espie et al. (1989) conducted a study into the validation of insomniacs' self-report of sleep patterns. They found modest but significant subjective overestimations of not only sleep latency but also sleep duration. The idea that individuals who complain of poor sleep habitually exaggerate sleep complaints was not supported by their data. These contrary findings stress the importance of realising that poor sleep is a complaint based on subjective experience, just like pain.

Discrepancies between objective and subjective qualities of sleep, often contrived as differences between sleep duration and sleep difficulties, are interesting and difficult to explain. No connection has as yet been made between objective, measurable categories, such as EEG patterns and sleep duration, and the subjective experience of how good or poor sleep has been. In this respect, the importance of sleep beliefs is frequently mentioned in the literature. The most prominent example being the belief that we need 8 hours sleep per night. Naitoh et al. (1990) for example, stressed the importance of sleep beliefs and the resulting anxiety about sleep loss. Horne (1985) even stated that sleep quality and not sleep quantity seemed to be the key.

2.3. Sleep and age

Age has been mentioned as the most important factor in sleep related changes (Morin 1993). During our lifespan, various aspects of sleep change. Not only the proportion of time spent awake and asleep changes across age groups, but also the amount of time spent in various sleep stages. Total sleep time is highest in infancy and gradually declines, levelling off in young adulthood. Average sleep time per 24 hours decreases from 16-18 hours in infancy to 10-11 hours in early childhood and about 7-9 hours in the mid 20s. Advanced age is associated with increased time spent in bed at night, with an increased number of nocturnal awakenings and increased time spent napping in the day time (Minors et al. 1989). In addition, with advancing age, more people become aware of sleeping disorders or use sleeping aids, and finally most elderly people are aware of early sleep onset and morning awakening (Nakazawa et al. 1991). Weitzman et al. (1982) found the following factors to be age related: sleep efficiency, total sleep time, REM sleep latency, REM episode length, percent REM sleep in the last two hours of sleep, the length and frequency of arousals during sleep and the final wake.

In short: several aspects of sleep change as we grow older. The following aspects are considered in more detail below: polycyclic sleep pattern, sleep profile changes, sleep difficulties, changes in circadian rhythms and changes in sleep need.

2.3.1. Polycyclic sleep pattern

It is suggested that in later years there is a tendency for a polycyclic sleep-wakefulness pattern (Tune 1969). Nocturnal sleep is diminished in late life, and daytime napping is common practice in older people. When diurnal sleep is added to night-time sleep, the amount of sleep per 24 hour period remains fairly stable from middle age to late life (Morin 1993). Older people spend more time awake in bed. Consequently, sleep efficiency, or the ratio of time asleep to the total time spent in bed, is significantly decreased in late life (Morin 1993). By means of an explanation, Tune (1969) related the polycyclic sleep pattern in older age to the changing situation of older people: with age social and occupational pressures are reduced, which applied more to the men in this study than the women (see chapter 4 for more details). Monk (1989) also mentioned the relevance of a behavioural or social explanation in relation to changes in sleep pattern, next to, for example, biological changes. Changes in sleep pattern were considered to be influenced by changes in social pattern: e.g. retirement, social isolation, and boredom, which could explain increases in daytime napping.

2.3.2. Sleep profile

Sleep consists of 90 minute-intervals of REM and N(on)REM episodes. The proportion of time spent in NREM and REM sleep stages is age-dependent (Mauri 1990). The most significant of these changes, reflecting maturational processes, occur from infancy to late adolescence. New-born babies spend about 50% of their time in REM sleep. Infants go immediately into REM sleep, whereas adults enter sleep first through NREM. The percentage of REM sleep is stabilised by late adolescence (about 20-25%) and remains essentially unchanged until late life, when a slight decrease is noted. REM latency is also shorter and REM sleep is more evenly distributed throughout the night in older than in younger people (Reynolds et al. 1985). From puberty on, the proportion of stage 2 sleep remains fairly constant across age groups. As people grow older, there is an increase in stage 1 sleep and a corresponding decrease in stages 3 and

4. Diminished slow-wave sleep (stages 3 and 4) is very gradual and fairly constant from childhood to an older age. Nakazawa et al. (1991) report a remarkable decrease of stage 4 sleep with increasing age. With advancing age, the relationship between REM and NREM sleep stayed the same, but the NREM pattern changed.

In addition, the sleep profile of naps taken during the day is different from normal sleep. Naps taken in the morning tend to contain a majority of REM sleep and little SWS, naps taken in the afternoon contain more SWS and less REM (Horne 1985)

2.3.3. Sleep difficulties

Sleep-related changes in older age were accompanied by more frequent and longer nocturnal awakenings in older people (Webb & Campbell 1980). Subjectively, these changes are experienced as lighter and more fragmented sleep, which may account for the increased prevalence of insomnia complaints in late life. Increases in physical illnesses (pain), medication use, and other sleep pathologies (e.g. sleep apnoea) with ageing exacerbate these complaints in older adults. Elderly people with insomnia complaints reported longer sleep latency and more frequent and longer awakenings and used sleeping aids more often than those without complaints (Morin & Grambling 1989).

2.3.4. *Changes in circadian rhythms*

With advancing age, circadian rhythms change and these changes are likely to affect sleep and daytime functioning. The most consistent finding is a reduction of rhythm amplitude which has been predominantly reported for body temperature: the rhythms flatten. As a result, older people sleep fewer hours during the night and are more likely to take naps during the day. This is made easier by the changes in amplitude of their rhythms and would explain the polycyclic sleep pattern of elderly people. Buysse et al. (1993) studied napping and 24 hour sleep/wake pattern in younger and older subjects and found their results to be consistent with an age-related decrease in amplitude of circadian sleep propensity rhythm or with the expression of a semi-circadian (12 hour) sleepiness rhythm.

Furthermore, there is evidence of change in temporal order of circadian system: older subjects have relatively advanced rhythms. In addition, their free-running period length (or 'tau') is shorter (24.47 hours) compared to younger persons (25.05 hours). A shorter tau is associated with a more advanced rhythm phase. Nakazawa et al. (1991) also observed a significant inverse correlation between age and acrophase time in elderly. These results agree with the finding of increased morningness in older people, i.e. they wake up earlier and go to bed earlier. It is however not clear if there is a causal link between the two (Monk & Folkard 1992).

In addition, there is evidence of reduced strength of circadian control: greater susceptibility to the occurrence of rhythm disturbance. The rhythms tend to desynchronise more easily with advanced age. There is a decay of temporal organisation during the ageing process. Often a spontaneous internal desynchronisation of two or more rhythms has been observed with advancing age. This is also called "phase lability" i.e. the rate at which the circadian system can re-align to be appropriate to a new routine. Research results have suggested that the circadian rhythms of middle-aged people are slower to re-align to an acute change in routine than are those of the young. What probably can be concluded is that there is a less strong link in the elderly between the endogenous circadian processes and the actual sleep-wake cycle selected. (Åkerstedt & Torsvall 1981, Brock 1991, Härmä 1993, Härmä et al. 1990, Kerkhof 1985, Minors et al. 1989, Minors & Waterhouse 1990, Moe et al. 1991, Monk 1989, Monk & Folkard 1992, Nakazawa et al. 1991, Rosa et al. 1990).

Looking at circadian characteristics as a possible predictor of sleep in older subjects, Monk et al. (1991) met with a surprising result. In this study, they looked at the question whether circadian characteristics could successfully predict objectively recorded sleep in older subjects. Healthy older adults (N=34, self-described good sleepers, mean age 83.1) were compared to 30 young controls. The general results fitted in well with the idea that older people have worse sleep. In almost all laboratory measures the older group slept poorly compared with the young, acquiring about one hour less total recorded sleep. The older group showed an earlier habitual time of waking than the young, and showed more morning type scores on test instruments. They also showed a lack of flexibility in sleep patterns and less intrasubject and intersubject variability in habitual sleep timing compared to the young.

When looking at the possibility to predict which one of the older subjects were likely to obtain the most sleep, however, a surprising and counterintuitive result was found: older subjects' morningness test scores were significantly associated with objectively measured sleep durations, with a tendency toward morning type circadian orientation being associated with *longer* sleep. In other words: the morning types (i.e. those most likely to be older) were the ones who slept longest. Thus, the authors conclude, when one is in one's ninth decade, it may be better (from a sleep point of view) to be a morning lark rather than a (comparative) night owl. An explanation offered by the authors, was that the circadian system at that age may be pushing one towards a 'morning type' orientation, and that those seniors who adjust their behaviour to be in tune with that orientation are in harmony with it and thus sleep longer, while those who fight to remain more evening type in their behavioural pattern have to pay a price in terms of lost sleep.

Explaining age-related circadian changes

Several possible explanations for the observed changes in the circadian system have been suggested in the literature: biological changes and behavioural changes. Explanations for such changes are generally based upon the concept that any measured circadian rhythm is derived from an endogenous component (produced by the body clock), and an exogenous component (resulting from rhythmicity in our environment). One explanation is that the internal clock might deteriorate with age or its effectiveness might appear to decrease, the idea being that the clock acts upon some function that is less easily stimulated with age. In addition, there might be changes - such as decreased mobility and increased napping in the daytime, and increased awakening at night - which will decrease the day-night differences in an individual's lifestyle (Minors et al. 1989). Moe et al. (1991) concluded that the amplitude reduction may be the result of age related changes in behavioural pattern or reduced amount of exposure to bright light. Monk (1989), finally, suggested three possible reasons: first, the circadian oscillator is generating a weaker signal, second, circadian entrainment mechanisms are weaker (for behavioural or physiological reasons) resulting in a desynchronised circadian system, and third, it could be that behavioural patterns of the elderly merely 'mask' the circadian rhythms so that they appear to have a reduced amplitude. For example, frequent wakings during the night for bathroom use may raise an otherwise falling circadian temperature rhythm. In this study, results suggested that circadian differences between young and old may be largely due to changes in behavioural patterns. Differences in temperature amplitude between young and old men largely disappeared when the circadian rhythms were unmasked.

2.3.5. Sleep need

There is some discussion in the literature about whether or not the actual sleep need of older people changes. According to Morin (1993), the ability to sustain sleep uninterruptedly through the night, rather than sleep needs per se, may be somewhat diminished with age. This is, according to Morin, contrary to the commonly held belief that sleep needs decrease with ageing. Morin argued that this process is analogous to natural age-related declines of some physical and cognitive skills. The sleep pattern of the 'very old' is characterised by polyphasic sleep-wake cycles. Instead of being consolidated in one period, their sleep (6-8 hours total) is obtained in two to four episodes; this pattern is developmental similar to the polyphasic sleep cycle of infants (Dement et al. 1982). Ceizsler et al. (1992) remarked upon the lack of evidence that the need to sleep decreases with age; it seems rather that the timing and consolidation of sleep change. They also mentioned the compensatory day time naps.

Bliwise (1993), however, states that one of the common "myths" regarding ageing and sleep is, that the need for sleep does *not* change with age. Arguments for and against this notion have waxed and waned over the years, according to Bliwise. Some studies which find no change include napping in their totals, thus implying a redistribution of sleep around the 24-hour day. If, in fact, net sleep amounts do not change with ageing, the need for sleep may be just as strong in old age, but that need may be met differently. Napping in old age, however, cannot simply be equated with unfulfilled sleep, because both cultural and social factors as well as boredom undoubtedly play a role. Physiological studies of daytime alertness in elderly subjects provided some additional support for the notion of a modified expression of sleep need. Taken as a whole, studies of experimental sleep deprivation suggested, according to

Bliwise, that, although some differences by diagnosis, gender, amount of sleep loss incurred or particular variable under consideration may exist, the fundamental homeostatic response to sleep loss in the elderly is preserved. Results of studies by Carskadon and Dement (1985) and Bonnet and Rosa (1987) suggest however that most aspects of sleep architecture were modified only on the first night of postdeprivation recovery sleep in their elder subjects, whereas in younger subjects the effects persisted for several additional nights.

Bliwise concluded that it is clear that to speak of continued sleep need (or modification thereof) in old age is an overly simplistic concept, which is not consistently and unequivocally supported by the existing knowledge base. Studies generally show divergent results, which can be variously construed as evidence for an age-related decreased need, an unchanged need, an unchanged need but deficient mechanism or perhaps an alteration in type of need. Finally, he argues, that it must be recognised that any examination of sleep need presupposes a thorough understanding of sleep function.

Irrespective of whether or not sleep need changes with ageing, most authors did agree that it is important to consider perceived sleep need, as an indication of sleep beliefs, when looking at sleep difficulties because of their importance in relation to sleep difficulties (Horne 1985, Naitoh et al. 1990). In a study into differences between elderly with and without insomnia complaints, Morin et al. (1989) even found that the main predictor of insomnia complaints was a discrepancy between sleep requirement expectancies and actual sleep.

2.3.6. *Are ageing and deterioration really synonymous?*

From the above the conclusion seems warranted that ageing is strongly associated with deterioration or increased fragility of sleep and of the functioning of the circadian system. However, there are a number of studies, focused at the age, sleep, and circadian rhythm relationship, which cast some doubt on the ubiquity of the assumed relationship and on some of the explanations offered.

Reynolds et al. (1991a), for example, found in their study, that healthy persons in late old age may have a level of daytime sleepiness no greater than or perhaps even less than, that seen in healthy young adults. In addition, Brendel et al. (1990) concluded that the results of their sleep deprivation study suggested that acute total sleep loss may be a more disruptive procedure for the young than for the old.

In terms of explanations for impaired sleep of older people, Monk et al. (1992b) studied the hypothesis that the impaired sleep of older people might be due to circadian dysfunction stemming from irregularity of life-style (i.e. a social rather than a biological explanation). Contrary to prediction, the results revealed that the older group had just as many activities completed and just as much 'other-person' involvement as the young, despite showing reliably impaired subjective and objective sleep. According to the authors, the results suggest either that these seniors have always been regular in their life-style and that this has been protective of their health and vigour, or that their regularity has been developed as an adaptive response to age-related changes in their circadian system.

In a study into rhythmic versus homeostatic influences on mood, activation, and performance in young and old men, Monk et al. (1992a) found that body temperature confirmed that the old had as robust an endogenous circadian rhythm generation mechanism as the young. Separate from this process, there appeared to be some attenuation with advancing age, which seemed to explain the found relative absence of rhythmic expression in various mood and performance variables in the old.

In a fairly recent study, Monk et al. (1995), explored whether or not older men and women have circadian body temperature rhythms different from those of younger adults. Several protocols were used: normal routine and constant conditions (which allows for more control of exogenous influences). There was some evidence for an age-related phase advance in temperature rhythm, especially for older men on a normal routine, though this was not present in the constant conditions protocol. However, there was no statistically significant evidence from any of the protocols suggesting that older subjects generally had lower temperature rhythm amplitudes than younger adults: "despite a large sample size none of our analyses produced a general statistically reliable decrease in amplitude when old versus young were compared. Although the present results were not strongly contradictory to the 'conventional wisdom' that circadian rhythms flatten and move to an earlier phase with advancing age, they were not that supportive either".

Several possible explanations were put forward by the authors for the attenuation of the age-effect on circadian rhythms, that seemed to be evident in this sample, despite their truly advanced age. Because of their relevance to the subject of this thesis, these explanations are summarised below. First, with regard to circadian temperature rhythm amplitude effects, the role of gender was mentioned. It may well be that the age related reduction in temperature amplitude only occurs reliably in a minority of the people affected (i.e. the men). According to Monk et al., it is remarkable that older women were not studied in the two publications that are most often cited as evidence for age-related amplitude reduction in the human (Weitzman et al. 1982 and Vitiello et al. 1986, both in Monk et al. 1995). Moreover, the subsequent carefully controlled studies of several other authors all showed older women to have significantly higher amplitudes than older men. Possibly related to this is another finding that the objective sleep quality (Reynolds et al. 1991b) of older women has also been found to be superior to that of older men. Next there was the nature of this elderly sample: active and involved members of the community with sufficient energy to volunteer for university sleep experiments. These subjects represent the hardy survivors, rather than the normal aged. It could well be that robust, high amplitude circadian rhythms are part of the cluster of attributes that have kept these people active and vital so late in life. Finally, a rather technical explanation in terms of the circadian rhythm process was offered: age-related circadian dysfunction may occur 'downstream' from the rhythm generation process. Thus the circadian signal may be quite strong at the ageing person's body clock, but have less ability to 'get through' as expressed circadian rhythms, comparable to the inability of the elderly to generate as much of the deepest sleep level as the young do. This explanation was supported by the finding that robust temperature rhythms in the aged during unmasking, were not necessarily associated with equivalent rhythmicity in subjective activation and performance. Rather, activation and performance appeared to be more dominated by homeostatic (time since sleep), rather than rhythmic (circadian pacemaker generated) processes (Monk et al. 1983). Such effects may be manifest in everyday life by a weakness with age in the circadian rhythm of sleepiness. This weakness may, in turn, lead to the polyphasic sleeps and increased napping evidenced by many elderly people. These disrupted sleep-wake patterns may then, in turn, through masking effects and impoverished zeitgeber exposure, produce circadian rhythms that lack the robust amplitudes characteristic of youth. The authors conclude that the present results suggest that caution should be exercised in asserting that advancing age necessarily results in flatter and earlier phasing circadian body temperature rhythms. In very healthy seniors (even into the ninth decade of life), such effects were, at best, rather weak. This was especially true for older women, whose temperature rhythms were similar to those of young men (Monk et al. 1995).

These results point to the fact that the assumed deterioration of sleep and the circadian system, may be more complicated than has been assumed until now. Although a gradual decline related to ageing cannot be denied, the results also point to the possibility that the relation is less straightforward or less linear than has been understood to date. It may well be that the generally assumed deterioration does not allow enough for individual differences, such as gender, deterioration of health with advancing age, and different personal circumstances.

2.4. Literature summary

Age-related changes in our sleep pattern are well documented in the literature. With age, sleep becomes more fragile and polycyclic: daytime napping occurs more frequently. Furthermore, increased morningness was found in older persons, and insomnia complaints have been reported to increase with age. Whether or not actual sleep need changes is less clear. However, the importance of sleep need as a sleep belief was stressed.

Where changes were observed, several causes for these changes have been suggested. Looking at the paragraphs above, in research, the emphasis appears to be on biological aspects. Next to these, however, social aspects need also be considered. Changes in circadian rhythms, as an exponent of biological influences, were considered to be of prime importance in relation to age related sleep pattern changes. In addition, changes were also considered to be related to changes in social pattern: e.g. retirement, social isolation, boredom, which could explain increases in daytime napping.

In general, it was concluded that both sleep quality and quantity reduces with advancing age. However, some research results caution us in reaching this conclusion too quickly and too definitely. Monk and colleagues have reported results which give reason to doubt the firm belief that the sleep of older people is always and in all aspects inferior to the sleep of younger adults. It may well be that the moderating influences of several individual differences have been neglected when considering this relationship. As was mentioned above, most notably gender and individual circumstances were put forward in providing additional explanations for some of the more controversial results found. More attention to these interesting findings in relation to age and sleep will be given in the next two chapters. Here attention will first turn to an analysis of the relationship between age and sleep in the sample under study.

2.5. Analysis

In the analysis-section, attention will focus on the relationship between age and sleep in the sample studied. All analyses were conducted with different successive versions of SPSS, the final version was SPSS 7.5 for Windows. Based on the literature, the following research questions were formulated:

(i) is there evidence of age-related effects on sleep duration and sleep difficulties,

(ii) is there evidence of a change in sleep need,

(iii) does morningness increase with age, and

(iv) what is the relationship between sleep duration and sleep difficulties?

The aim of the analysis in this chapter is to investigate the strength of the relation between age and sleep difficulties and sleep duration, relative to the relation between age and health outcome measures. These measures include physical and psychological health (see appendix I).

Three points need to be kept in mind:

i) The first research question draws attention to the nature of the sample under study: shiftworking nurses. The implication is that when looking at sleep duration and sleep difficulties, these were scored for the different shifts worked by the nurses and thus all results for the different shifts will be reported. A more extensive description of the survey and the sample can be found in respectively appendix I and II.

ii) The subjects in this sample were still working which meant they were not very old, compared to samples studied in ageing research. The mean age of the sample was 33.24 with a standard deviation of 9.48, and a range from 20 to 63. This limits the extent to which this study can draw on the literature on ageing.

iii) Napping, although important in relation to age, will not be considered in this study. Only a minority of the shiftworking nurses reported naps and the frequency of naps was considered to be too low. Of the more than 1500 nurses, 956 reported no naps and 576 did. The frequency of naps was mostly 1 (N=447), 107 nurses reported two naps, 18 three and 4 four. Most naps were reported for night shifts, followed by morning shifts. And more naps were reported on rest days than on afternoon shifts.

2.5.1. The sample

A brief summary of the sample characteristics is given here. A more detailed description of the sample can be found in appendix II. The SSI was completed by 1532 nurses. The mean age of the sample was 33.24 (s.d. 9.48, range 20-63). In table 2.1, an age-group distribution is given. The table shows that only 8% of the nurses were 50 years or older, the majority (47%) is 20-29 years old. Still, 25% of the nurses is 40 years or older, the age-group for which the dramatic increase of sleep difficulties was reported in the paper by Kripke et al. (1979). There were 1405 women and 115 men in the sample (12 "missing"). The majority were living with a partner (66.4%) and just over half of the sample did not have persons that needed to be looked after by them (55.5 %). They had been in employment for an average of 14.51 years (s.d. 8.80), had worked shifts for 11.08 years (s.d. 7.43) and they had been in their present shift system for 5.85 years (s.d. 5.52). The average number of hours worked per week was 34.26 (s.d. 7.24). Two main variations of shift systems were worked: rotating shifts and permanent night shifts. In this sample, 52% of the nurses worked a rotating shift system, 38.6% worked permanent night shifts (9.5% missing data).

Table 2.1: Age groups

Age	20-29	30-39	40-49	50-63	Missing
N (1532)	713	417	268	120	14
%	47	27.5	17.7	7.9	--

2.5.2. Relation between age and outcome measures

In order to establish the importance of the age-sleep link, in relation to the relationship between age and other outcome measures in this study, this will be looked at first. The mean scores on the outcome measures can be seen in table 2.2. As can be seen from this table, sleep duration is shortest between two night shifts, followed by the morning shift. Sleep difficulties scores are also highest for the night shift, followed by the morning shift. Sleep duration is longest between two afternoon shifts, and sleep difficulties scores are lowest between two rest days.

Table 2.2:

Mean scores on outcome measures

Variable	Mean score (s.d.)	Range
sleep duration* between:		
two morning shifts	7.19 (0.95)	
two afternoon shifts	9.24 (1.30)	
two night shifts	6.88 (1.57)	
two rest days	9.15 (1.21)	
sleep difficulties between:		
morning shifts	17.96 (3.83)	6-30
afternoon shifts	15.26 (3.51)	6-30
night shifts	19.07 (5.08)	6-30
rest days	13.12 (3.62)	6-30
other outcome measures:		
chronic fatigue	25.00 (7.54)	5-50
GHQ	12.42 (5.30)	0-36
neuroticism	13.00 (3.05)	6-24
cardiovascular complaints	10.24 (2.63)	8-32
digestive complaints	13.87 (4.46)	8-32

* in hours

higher scores indicate more problems (with the exception of sleep duration).

In order to establish the importance of age in relation to sleep, correlations were calculated. As can be seen from table 2.3., most correlations between age and the outcome measures were negative, indicating that older people in this sample tended to have fewer problems and reduced sleep duration.

Table 2.3:

Correlations between age and the outcome measures

Variable	Correlation with age
sleep duration between:	
two morning shifts	-.04
two afternoon shifts	-.36**
two night shifts	-.24**
two rest days	-.39**
sleep difficulties between:	
morning shifts	-.13**
afternoon shifts	.03
night shifts	-.15**
rest days	.16**
other outcome measures:	
chronic fatigue	-.18**
GHQ	-.10**
neuroticism	-.20**
cardiovascular complaints	.07**
digestive complaints	-.18**

significant differences: ** $p \le 0.01$

For sleep, significant negative correlations with age were found for all sleep durations measured with the exception of morning shifts. These correlations indicate that, with increasing age, the nurses in this sample slept less on afternoon and night shifts, and on rest days. These correlations are all above .20, indicating a moderate relationship (Cohen 1988).

Correlations between age and sleep difficulties were surprisingly low: well below .20. For the afternoon shift, correlations between age and sleep difficulties were not significant. Sleep quality was significantly negatively correlated with age for sleep between morning and night shifts. The results indicate that older nurses in this sample had less sleep difficulties in relation to these shifts. The correlation between age and sleep difficulties on rest days was positive, indicating that older nurses experienced more difficulties with sleep on rest days.

Correlations between age and sleep duration were high compared to correlations with other outcome measures, stressing the importance of the relation between sleep duration and age. Although mostly significant, the correlations between age and sleep difficulties were average, when compared to the other outcome measures. Regression analysis results, reported in table 2.4., essentially confirmed these results.

Table 2.4: Regression analysis between age and the outcome measures

Variable	R^2	Beta weight
sleep duration between:		
two morning shifts	.000	- .035
two afternoon shifts	.125	- .355 ***
two night shifts	.058	- .242 ***
two rest days	.148	- .385 ***
sleep difficulties between:		
morning shifts	.016	-.130 ***
afternoon shifts	.000	.031
night shifts	.022	-.150**
rest days	.025	.160***
other outcome measures:		
chronic fatigue	.033	-.183 ***
GHQ	.009	-.101***
neuroticism	.038	-.195***
cardiovascular complaints	.005	.073**
digestive complaints	.032	- .180 ***

significant difference: ** p <= 0.01 *** p<= 0.001

2.5.3. *Age, sleep need and morningness*

Correlations were calculated between age, sleep need, and morningness. Age correlated .20 ($p < 0.001$) with morningness, indicating that older people in this sample were indeed more likely to be morning types. The correlation between age and sleep need was -.23 ($p < 0.001$). The negative correlation points to a perceived lower sleep need for older nurses.

Subsequently, sleep need was correlated with the eight sleep difficulties and sleep duration measures. Table 2.5. shows that correlations between sleep need and sleep difficulties were small. Correlations with sleep duration were moderate.

Table 2.5:
Correlations of sleep need with sleep duration and difficulties

Variable	Sleep difficulties Morning	Afternoon	Night	Rest day
Sleep need	.1049***	.0010	.0718**	-.0079

significant difference: ** $p <= 0.01$ *** $p<= 0.001$

Variable	Sleep duration Morning	Afternoon	Night	Rest day
Sleep need	.2587***	.2717***	.2464***	.3032***

significant difference: *** $p<= 0.001$

2.5.4. *Sleep duration and sleep difficulties*

For research question four, correlations were calculated between sleep duration and sleep difficulties. The results for the entire sample are reported in table 2.6. The only high correlation is between sleep duration and difficulties on night shifts. The other correlations, although significant (which is likely to be the result of the large sample size), were all below .20 and thus not considered to be very substantial.

Table 2.6:

Correlations between sleep duration and sleep difficulties for the different shifts

Variable	Sleep difficulties between two: morning shifts	afternoon shifts	night shifts	rest days
Sleep duration between two: morning shifts	-.1873			
afternoon shifts		-.1177		
night shifts			-.4155	
rest days				-.1927

all results are significant at a 0.001 level

2.6. Discussion

The relationship between sleep and age was investigated. From a review of the literature it was concluded that age is a frequently researched variable in relation to sleep difficulties and sleep changes. Sleep changes with age and these changes affect both the quantity and the quality of sleep. With advancing age, night time sleep becomes more fragile and sleep becomes polycyclic: daytime napping occurs more frequently. Furthermore, increased morningness was found in older persons, and insomnia complaints have been reported to increase with age. Whether or not actual sleep need changes seemed less clear. Also, there was some doubt about the negative relation between age and sleep. It may well be that the generally assumed deterioration of sleep with increasing age does not allow for enough individual variation.

Analyses of the data in this study addressed four questions: is there evidence for changes in sleep quality and quantity, does sleep need change with age, does morningness increase with age, and what is the relationship between sleep duration and sleep difficulties.

To start with the middle two questions, in this sample evidence was found for an increase in morningness with age, which is in line with the literature. In addition, a self-reported lower sleep need for older nurses was also found, indicating that at least the perceived sleep need of this sample reduced with age.

Regarding the last research question, only low correlations between sleep duration and sleep difficulties were found for all shifts, with the exception of the night shifts. Sleep duration and sleep difficulties were highly, negatively, correlated for sleep on a night shift. Here, reduced sleep duration was associated with more sleep difficulties

With respect to the first research question, a consistently high negative correlation for sleep duration with age was found for sleep between afternoon and night shifts and for sleep on rest days. No significant correlation was found for age in relation to the morning shift. The first finding confirms the change in sleep quantity as reported in the literature. The lack of change of sleep on the morning shift need not be too surprising. Sleep duration on the morning shift is among the shortest to start with, compared to other shifts (see mean scores), so a further reduction is not likely. In addition, the increased morningness may have influenced this result: morning types find it easier to go to bed in time before a morning shift.

For sleep difficulties, fewer problems were found for morning shifts which may also have been influenced by the increased tendency towards morningness. The reduction with age of sleep difficulties on a night shift is less easy to explain. These results contradict the dominant view in the literature that with age sleep difficulties on a night shift increase. The absence of a significant correlation for the afternoon shift is remarkable as this is the shift which leaves usually most room for sleep, which is reflected in the observed correlation with sleep duration.

In summary, for sleep quantity results were found to be in line with the literature. For sleep quality, the results were less clear. The reported increase in insomnia for women over the age of 40 (Kripke et al. 1979) was not supported by our data. The results seem to contradict a commonly held view in the literature. Therefore, it would be interesting to investigate this result further.

The unclear relationship between age and sleep difficulties gives rise to questions about factors that may moderate the relationship between age and the level of reported sleep difficulties in this sample. Two main factors mentioned are gender and personal circumstances (Morin 1993). In this sample, both are present. The nature of the work arrangement of the nurses in this sample, shiftwork, is likely to influence the relationship between sleep and age. Impaired and truncated sleep is one of the major complaints of shiftworkers and even more so of night workers. In this sample of mainly female nurses, gender and more likely gender roles are also factors to consider. In the next two chapters, attention will focus on these two factors and their influence on the relationship between age and sleep in this sample.

3

THE IMPACT OF SHIFTWORK

3.1. Introduction

In chapter two, attention was paid to sleep and age-related changes in our sleep pattern. It was concluded that various aspects of sleep change with age and that age is an important variable causing sleep pattern changes. The analysis section confirmed a gradual reduction of sleep duration with age. However, a parallel increase in sleep difficulties was not found. The results seemed to contradict the main view in the literature that sleep difficulties increase with advancing age, and even more so in women. Even when keeping in mind that the relationship between sleep duration and sleep quality is notoriously complicated, this result would fit in with Morin's (1993) conclusion that age alone or in combination with health problems cannot account for all insomnia problems in seniors. These findings point to the influence of individual differences. Circadian rhythm changes may not be the same for all persons, nor will changes in life style. Their subsequent impact on sleep problems or sleep appreciation may also differ between individuals. Given the nature of the sample under study, two potential sources of individual differences need to be considered: shiftwork and gender. In this chapter, attention will turn to shiftwork as a factor influencing the relationship between age and sleep. Gender differences will be the focus of the next chapter.

Shiftworkers' main problems are sleep complaints, and circadian rhythm changes are inextricably bound up with working at irregular hours. In this chapter, a shiftwork literature review will be followed by analyses of the impact of shiftwork on the relationship between age and sleep in this sample.

3.2. Sleep and shiftwork

There is an abundance of research on the sleep of shiftworkers. Sleep difficulties are a principal complaint of shiftworkers. Sleep can be disturbed in terms of sequence, duration, time of day, variance, and subjective experience or sleep quality (Tepas & Carvalhais 1990). The most direct and consistent finding is that shiftwork results in a periodic reduction in the quantity and impairment of the quality of sleep (Rosa 1991). Additional reported sleep difficulties of shiftworkers are: sleepiness, poor sleep quality, and lack of sleep. On average, shiftworkers sleep 7 hours less per week than their dayworking counterparts (Monk & Folkard 1985). Working shifts affects both sleep quantity and sleep quality. Complaints centre around impaired and truncated sleep (Åkerstedt 1985, Rutenfranz et al. 1977, Tepas et al. 1993).

In addition, in research into the effects of shiftwork, sleep variables have not only played an important role because difficulty with sleep is the most frequent complaint of shiftworkers, but also because sleep variables have proven to be sensitive markers for, for example, the effects of night work (Tepas et al. 1993).

3.2.1. Different shifts

The shift which most clearly affects sleep is the night shift, which requires the worker to sleep during the day and work at night. It is therefore not surprising that the vast majority of shiftworkers' sleep studies have concerned themselves with the day sleep following a night shift. There is however sufficient indication to consider the sleep related to other shifts, in particular the sleep related to morning shifts, as well as sleep on days off.

The night shift

Working night shifts requires shiftworkers to sleep during the day. Both retrospective cross sectional surveys and prospective sleep diary studies have indicated that night shiftworkers, who have to sleep during the day consistently obtain less sleep than day workers but also than evening shiftworkers. Reductions in sleep are concomitant with night work. The day sleep of a shiftworker is 1-4 hours shorter than night sleep. The shortening is taken out of stage 2 sleep (basic sleep) and REM sleep (dream sleep). Stages 3 and 4 (deep sleep) do not seem to be affected. Furthermore, sleep latency is usually shorter and REM often appears earlier (Åkerstedt 1985).

Next to being reduced in time, night shift workers reported their daytime sleep to be lighter, more fragmented or interrupted, and less restful than sleep obtained at night (Lavie et al. 1989, Rosa 1991, Tepas &

Carvalhais 1990, Tepas & Mahan 1989, Wilkinson 1992). Day sleep was less restorative. EEG studies of shiftworkers have confirmed the self-report studies (Walsh et al. 1981). Tepas and Mahan showed that these robust differences in sleep are even present in experienced permanent night shiftworkers who most prefer to work nights.

Time-isolation studies have shown that individuals seldom fall asleep when their body temperature is rising, despite the fact that their environmental conditions are constant. As a result, their sleep duration varies depending on the phases of the endogenous component of their temperature rhythm at which they fall asleep. These findings help to account for the fact that night workers have problems falling asleep, and record reduced sleep duration, between successive night shifts (Folkard 1996a).

When comparing reported sleep disturbances for the different shifts, Åkerstedt and Gillberg (1981) found that, irrespective of profession, night shift always caused more disturbances than day shifts. Night shifts were associated with difficulties maintaining sleep and feelings of not being sufficiently rested. Difficulties falling asleep were not a major characteristic of sleep disturbances related to the night shift but were found to be of importance for a sleep period before a morning shift.

The general pattern of decreased total day sleep time is apparent whether the worker has a permanent night schedule or rotates shifts (Tepas et al. 1981). Rotating shiftworkers however obtain less overall sleep than their counterparts on permanent schedules. Compared to other shiftworkers, night shiftworkers have the shortest sleep period, the longest nap period, sleep during the day, have a higher incidence of napping and sleep after rather than before work. As a group, they show a higher incidence of sleep complaints (Tepas 1982).

Less attention has been paid to day sleep at different times of the day, where different results were found, regarding the timing of day sleep. With the accumulated sleep loss after a night's work, the morning after the night shift would seem most suitable for sleep. This is however a change from the normal routine (work - leisure - sleep) to: work - sleep - leisure. Another argument for a day sleep later in time may be found in the distinctly different characteristics of day sleep from night sleep. These are mainly a reduction of total sleep time and a displacement of the distribution of REM. However, when sleep takes place in the afternoon rather than the morning, there is no clear difference (Benoit et al. 1980). Another finding would suggest the opposite. A steep decrease in sleep propensity was found from 06:00 to 12:00. This corresponds to the time at which shiftworkers typically try to go to sleep between night shifts, and suggest that the later they attempt to sleep the more difficult they will find it to do so (Folkard 1996a).

Escriba et al. (1992) evaluated the impact of shiftwork on the length and quality of sleep. For both male and female nurses, shiftwork led to a reduction in sleep length and an alteration in the quality of sleep. No increase in the use of sleeping aids was found. Least sleep was found for permanent night nurses after a night shift compared to rotating shift nurses. However, this result may well have been influenced by the shift system in use, where permanent night nurses had a day off after each worked night shift, thus minimalising the need and opportunity to adjust to a night shift routine. Rotating nurses usually worked 7 night shifts in a row.

Frese and Harwich (1984) found that the greatest loss of sleep time was after a night shift, followed by night-time sleep after a morning shift. The change in sleep was characterised by difficulty in sleeping, intermittent sleep, and early wakening. In addition, the length and quality of night shift workers' sleep were related (less sleep, worse quality). Compensation of lost sleep was found on afternoon shifts and days off.

Controlled studies of experienced night shiftworkers have repeatedly found that night work decreases sleep length and may result in an increase in sleep complaints. The reduction in sleep length is probably the most robust finding in the research literature, having been demonstrated in a wide range of studies from several countries. On average, permanent night shiftworkers sleep longer on their days off, but they still sleep less per week than do day workers (Tepas & Carvalhais 1990).

The morning shift

Sleeps preceding a morning shift have been found to be short, sometimes as short as, or even shorter than the day sleep between night shifts. Not only was sleep truncated but also reduced in quality (Folkard et al. 1990, Knauth et al. 1980). It would seem obvious to concentrate on problems associated with the time of day shiftworkers have to get up in order to work this shift. However, difficulties falling asleep prior to this shift should not be underestimated.

Morning shifts commonly start very early (around 06.00 or 07.00 am). Around 04.00/05.00, when shiftworkers should rise, they have difficulties awakening. These difficulties emanate from the experienced sleep loss, and from their circadian rhythms, which at that point are at their lowest ebb (Åkerstedt 1990). As a result, shiftworkers do not feel rested. It would thus seem appropriate for shiftworkers to retire earlier preceding a morning shift in order to increase their sleep duration. However, this implies that they have to retire when they are not feeling tired. (Åkerstedt 1985, 1990, Åkerstedt & Gillberg, 1981, Folkard & Barton, 1993).

Two reasons have been given for the reluctance of shiftworkers to retire earlier preceding a morning shift. First, it has been assumed that this may be due to social pressures. Secondly, recently it has also been suggested that the circadian psychophysiology might make it more difficult to fall asleep as early as needed (Åkerstedt 1990). In this light, Folkard and Barton (1993) tested the hypothesis that this may be due to a 'forbidden zone' for sleep when sleep propensity is greatly reduced (Lavie 1986). Sleep propensity starts to increase from about 21:00 to 02:00. Further, the precise timing of the steep increase in sleep propensity after about 21:00 has been shown to vary across individuals, and is even steeper when individual records are examined (Lavie 1991). This increase has been termed the 'sleep gate' that terminates the period of some hours, known as the 'forbidden zone' for sleep, during which sleep propensity is extremely low. In their results, Folkard and Barton found some indication that a 'forbidden zone' may be of influence. It could be possible that this zone may discourage individuals from going to bed much earlier than normal. Sleep difficulties associated with the morning shift are thus influenced both by social and biological factors.

The afternoon shift

The afternoon shift generally did not cause problems. Shiftworkers usually commented on it being the only shift for which no alarm clock needs to be set. Because afternoon shifts end late (around 22.00/23.00), shiftworkers went to sleep later than usual, i.e. after 24.00. However, the advantage was that they could sleep longer the following morning. No evidence for systematic sleep problems or reduced sleep associated with this shift was found.

Rest days

The sleep pattern on rest days varied and was mostly related to the shift which was worked before the rest day or rest days. Rest days after night shifts were commonly used to catch up on sleep. Rest days following afternoon or morning shifts were more likely to be used for recreational or domestic purposes, i.e. to catch up on social activities. Frequently, there would be some competition between the two. Sleep on rest days was, in addition, influenced by the shift which followed the rest days: rest days before a night shift was used for 'prophylactic' sleep, i.e. in order to prevent or reduce anticipated sleep loss.

In summary, working shifts is associated with reduced sleep and reduced quality of sleep. Some shifts affect sleep more than others. The night shift is most renowned for its impact on sleep quantity and sleep quality. Nevertheless, the impact of the morning shift should not be underestimated. Because of their odd working hours, shiftworkers lose out on sleep and social activities. Rest days are used for catching up on both. Frequently, there will be some competition between the two.

3.2.2. Sleep quantity and quality

There is no evident relation between sleep duration and sleep quality in relation to the effect of shiftwork. Some studies, e.g. Escriba et al. (1992), Frese and Harwich (1984), did find that sleep quality and quantity were related: less sleep was usually associated with poorer quality sleep. However, a lack of relationship between the two variables has also been reported. In a study by Mahan et al. (1990), sleep length did not appear to be related to the incidence of reported sleep difficulties. This observation is similar to findings reported in the previous chapter, where it was already concluded that sleep quality and sleep quantity are to a large extent separate entities.

3.2.3. Disorder or difficulties

The question has been raised whether the sleep problems of shiftworkers are sleep difficulties, (i.e. not structural in nature) or whether they could be a disorder. An imbalance in a person's sleep architecture may be indicative of a sleep disorder. Sleep disorders are primary (narcolepsy, apnoea) but can also be secondary to medical, psychiatric, and behavioural problems (Mauri 1990).

Several authors have considered this question. Mahan et al. (1990) suggested two possible explanations for reported reduction in sleep length: sleep reductions could be related to sleep disturbances or sleep reduction would be mainly due to a sleep deficit caused by the voluntary choice of shiftworkers to delay sleep onset and reduce sleep duration. Their survey data demonstrated that permanent night workers reporting sleep difficulties, as well as those who do not, report sleep reductions. This finding is interpreted as supporting, in part, the position that night shift workers suffer primarily from self-induced sleep deficit. And again, sleep length in their study did not appear to be related to the incidence of reported sleep difficulties in this study. Regestein and Monk (1991) asked a similar question: is the poor sleep of shiftworkers a disorder or not. Their conclusion is similar to Mahan et al.: as a clinical phenomenon sleep altered by shiftwork is common and varied, probably expresses nonphysiological sleep-wake scheduling, and is little treated. Therefore, in this study the term disorder will not be used in relation to the sleep problems of shiftworkers.

3.2.4. Biological and social factors

Explanations offered for the sleep difficulties and reduced sleep length experienced by shiftworkers can be grouped into two, not mutually exclusive groups: biological and social factors. From a biological point of view, the most important factor is circadian rhythmicity (Minors & Waterhouse 1985). As was explained in the previous chapter, through our circadian rhythms our body is geared towards sleeping at night and being active during the day, our normal sleep-wake cycle. As a result, sleeping at unusual hours will be difficult, as well as staying awake at unusual hours. The disruption of the sleep-wake cycle in shiftworkers will affect the day sleep of night workers for which shiftworkers find it more difficult both to fall asleep and to stay asleep. Day sleep is less restorative than night sleep. Circadian rhythmicity will also affect the sleep duration and sleep quality in relation to morning shifts, which often require shiftworkers to wake up when their rhythms are at their lowest ebb and to retire when they are not feeling tired (Åkerstedt 1985, Folkard & Barton, 1993).

Within the context of the circadian rhythms, the 24-hour Sleep Propensity Function and the concepts of forbidden zones and sleep gates have already been briefly mentioned when the morning shift was discussed (Lavie 1986, 1991). Lavie has developed the concept of the 24-hour Sleep Propensity Function (SPF) which he considers to be the gatekeeper of transition between sleep and wakefulness. This SPF shows both circadian and ultradian variations. Morning persons have a prominent mid-afternoon sleepiness peak, evening persons do not. Lavie observed forbidden zones for sleep lasting for about four hours, during which sleep propensity is greatly reduced. This forbidden zone is terminated by a 'sleep gate' i.e. a sudden and dramatic increase in sleep propensity, that generally occurs between 21.00 and 04.00 depending on a person's habitual sleep timing. Lavie also showed that the timing of this sleep gate correlates highly with the phase of the circadian rhythms in body temperature and melatonin, and that the sleep gate differs for morning and evening types. In this light the results by Webb and Bonnet (1978) are interesting. They found that morning types tend to sleep the same number of hours each night compared to evening types, which may be related to differences in sleep gate. Lavie's results clearly showed that for each individual there is a specific sleep gate from which time on a sleep-wake transition can be easily made. Just before the sleep gate subjects showed a pronounced decrease in sleep propensity (Lavie 1986). The forbidden zone has already been related to difficulties in going to bed earlier preceding a morning shift (Folkard & Barton 1993).

Interacting with both sleep and circadian rhythm factors are social and domestic factors (Monk & Folkard 1992). The direct environment of the shiftwork affects the sleep of the worker. Day sleep is impaired by noise, light and temperature. Sleep is also influenced by social activities and social and domestic commitments. Most social activities happen during the day, in the evening and in weekends. Their limited capacity to participate in these activities will often result in shiftworkers sacrificing sleep. Domestic commitment can affect the amount and quality of sleep of the shiftworker as well. Especially in the case of female shiftworkers, with young children, sleep may often be reduced in order to meet domestic demands. This will be addressed in more detail in the next chapter. A shiftworker will be confronted by conflicting demands and limited time available which forces them to make choices. Sleep will not always be the obvious choice.

Several authors have looked at the impact of social factors relative to the impact of biological factors. For example, Åkerstedt and Gillberg (1981) reported that environmental disturbances did not seem to play a major role in day sleep difficulties. Rather, sleep at day time was interfered with by internal factors. This was based on a laboratory study of six persons in an isolation unit, with no gender information specified. In another study, Anderson and Bremer (1987) studied sleep duration at home and sleepiness on the job in rotating 12 hour shiftworkers. They found that in their sample of 29 shiftworkers, social factors explained the shorter sleep period of some workers (most notable the presence of children). On the whole, very few studies have explicitly tried to answer this question (with the exception of gender related research). It seemed more important to acknowledge their interrelated nature. For example, exogenous influences such as noise and light influence the circadian rhythms. And circadian rhythms influence the willingness or ability to participate in social activities.

3.2.5. Adjustment

Adjustment of shiftworkers to their work routine is mostly discussed in terms of biological adjustment or circadian adjustment. Disruption of circadian rhythms and subsequent (lack of) adjustment has already been discussed in the previous chapter. It was concluded that circadian rhythms can only adjust to change to a certain level.

Shiftworkers are being confronted with a frequently changing 'time-zone'. From a circadian point of view, shiftwork is unnatural and requires re-alignment of the circadian system towards night or evening work. That re-alignment process is slow, taking several weeks (or more) to adjust to night work for example. During the re-alignment process the shiftworker will not only be suffering from sleep disruption due to exogenous processes (traffic noise, domestic responsibilities) but also suffering from sleep difficulties associated with a misaligned circadian system. Moreover, the circadian function itself may produce 'jet-lag' type symptoms of malaise, irritability, gastrointestinal dysfunction and impaired performance which will be added to those of sleep loss (Monk & Folkard 1992).

Shiftworkers' rhythms never fully adjust to their work routine. Shiftworkers change shifts and even if they work a permanent shift, they are not isolated from the societal pattern on their days off. Some adjustment does occur but it is insufficient. Adjustment to nightwork results in a flattening of rhythms, i.e. a decrease of the amplitude. However, no change in phase estimates was found (Åkerstedt, 1985, 1990). Knauth and Härmä (1992) looked at the impact of amplitude and phasing of circadian rhythms as possible predictors of tolerance to nightwork. Their results did not confirm their hypothesis that a small circadian amplitude facilitates a more rapid adjustment to night work. Another major determinant of the degree of adjustment was the nature of the shift system under consideration. Thus, for example, the rhythms in both body temperature and self-rated alertness (or sleepiness) typically showed very little adjustment to a rapidly rotating shift system and most adjustment on a permanent shift system (Folkard 1996a).

Less emphasis has been laid on social adjustment. It is however assumed that shiftworkers adjust their social life to their work routine. Shiftworkers are known to socialise more with other shiftworkers and to engage in solitary hobbies such as fishing and photography. In addition, the family around the shiftwork has to adjust to their work routine: e.g. children must learn to be quiet during the day when the worker sleeps and partners have to get used to visiting relatives and family occasions alone and to spending weekends and nights alone. For example, with increasing age, female partners often report feeling less comfortable about spending nights alone at home, especially when the children have left home (Spelten 1988).

With regard to differences in adjustment, attention has been paid to differences between morning and evening types. Evening types may show greater circadian adjustment over successive night shifts than morning types. The general pattern appeared to be that morning types show little, if any circadian adjustment, while evening types may delay the phase of their temperature rhythm by up to one hour per day (Folkard 1996a). Other studies have examined the differences that might be associated with age and gender. These will be addressed in more detail in the next chapter.

3.2.6. Napping

A common way in which shiftworkers deal with their sleep deficit is by taking more naps than dayworkers. Three types of naps have been distinguished: prophylactic naps, replacement naps and maintenance naps (Rosa et al. 1990). Several studies have looked at the effect of napping and have considered the question whether napping is an appropriate strategy for dealing with sleep loss. According to Åkerstedt (1985) it is not known whether naps are compensatory or not. In general, Tepas and Carvalhais (1990) state that the correlation between workday sleep and nonwork day sleep (either naps or rest day sleep) should be *negative* if the nature of nonwork sleep is compensatory, which was not the case in their sample nor in the sample under study (Spelten et al. 1995). Rosa et al. (1990) contend that naps have good potential as an effective intervention for reducing fatigue and promoting adaptation to night shifts, but naps can be detrimental in that they can be an excuse to sacrifice regular sleep. Rosa (1992) found napping to be used as a compensatory strategy but also found that alertness on napping days in comparison with non-napping days was diminished, which does not support a compensatory view of napping. The author suggests that decreased alertness on nap days may result from poorer sleep quality or from differences in sleep timing and circadian adaptation on those days. An alternative explanation could be that naps fail to compensate enough. When looking at the effect on performance, Bonnet (1990) found a difference between prophylactic naps and replacement naps. Naps appeared to be most advantageous when the accumulated sleep debt was least which would argue in favour of prophylactic naps.

Horne (1985) noticed that naps taken in the morning and the afternoon differed in their restorative properties: naps taken in the morning contained a preponderance of REM sleep and little SWS and naps taken in the afternoon contained more SWS and less REM. Napping studies have shown that REM sleep is concentrated in the morning hours, while SWS is a function of the amount of prior wakefulness (Åkerstedt & Gillberg 1981)

Tepas et al. (1993) concluded that age and gender did not appear to have an effect on nap behaviour. The data furthermore confirmed other research, suggesting that permanent night shiftworkers not only take longer naps but also are more likely to nap more frequently during the work week than workers on other shifts. Therefore, the difference in the quantity of total sleep reported by night shiftworkers and workers on other shifts appear to be minimal, even if it is assumed that these workers nap every day, which is a very questionable assumption. Moreover, for those night shift workers who do report napping, the quality of sleep is questionable. In general the quantity and quality of sleep appear to be poorer for experienced night shiftworkers who frequently nap. In another study, Tepas (1982) concluded that night shiftworkers who do not report napping showed a significantly lower incidence of sleep complaints than those who report nap times.

In summary, naps are frequently taken by shiftworkers, as a result of sleep loss. There is however no unison on the positive effect a nap has on subsequent performance nor on the compensatory function in relation to lost sleep.

3.2.7. Organisation of the night shift

In the above section, frequent mention has been made of studies where 'permanent night' workers were compared to 'rotating shift' workers. The night shift is the shift which causes most problems in relation to sleep. One way in which organisations have tried to reduce these problems is by offering a permanent night shift, thus reducing the number of night shifts worked by rotating shiftworkers and hoping for better adjustment of the night workers to the night shift. In general, research has shown that workers on these permanent night systems indeed fare better when their sleep is considered. A number of these results have been summarised above. Some studies, such as Escriba et al. (1992) reported reduced sleep duration and quality for the night shift. In this study, however, rest day sleep was not taken into consideration. In addition, the night shift was organised in such a way (one off, one on) that adjustment was minimalised. These factors could well explain the found reduced sleep and still not argue against the general notion that a permanent night shift works better. A major factor in the positive results of working permanent nights seems to be choice (Barton 1994). Most permanent night workers choose to work this system which will influence their appreciation of the system and their adjustment to the system. It can be assumed that workers who have real problems working nights will not choose to work this system.

3.3. Sleep and age in shiftworkers

3.3.1. Similarities

The effects of shiftwork on the sleep of the worker are surprisingly similar to the age-related sleep changes which were discussed in the previous chapter. The (day-)sleep of shiftworkers is more fragile, and contains less SWS (Åkerstedt & Torsvall 1981). Shiftworkers napped more than dayworkers. Furthermore, as a result of the continuous process of re-alignment, the amplitude of their rhythms was reduced, resulting in a flattening of rhythms.

Equally, the sleep of older people was found to be more fragile, i.e. shorter, more easily interrupted, more fragmented and lighter. Their rhythms desynchronised more easily and the amplitude of their rhythms changed: their rhythms flattened. In addition, there are suggestions that the circadian rhythms of older or middle-aged people are slower to re-align (phase shift) to an acute change in routine (Monk & Folkard 1992). As a result of these changes, older people often slept less hours during the night and were more likely to take naps during the day, which seemed to be made easier by the changes in amplitude of their rhythms. The low amplitude of older people, in combination with early phasing circadian rhythms could be due to a shortening of the natural period of the endogenous circadian pacemaker.

Such a change is associated with a move towards morningness, indicating that older people are also more likely to be morning types, which is however not necessarily the case with shiftworkers (Monk & Folkard 1992).

There is fairly good evidence for a gradual reduction in the amplitude of circadian rhythms with age and recent research suggests that this is largely due to a reduced exogenous component. The endogenous component of at least the temperature rhythm of older people would appear to be both relatively normal, and to adjust to a change in the sleep/wake cycle at the same rate as that of younger subjects. Despite this latter finding, older subjects showed greater and more prolonged disturbances of their sleep and mood following a change in sleep timing, suggesting that the precise nature of the body clock's control of sleep may change with age (Folkard 1996a).

3.3.2. Tolerance and adjustment of older shiftworkers

The similarity between shiftwork complaints and ageing related sleep changes, has not gone unnoticed and attention has been paid in research to the tolerance and adjustment of the worker who combines the effects of both shiftwork and ageing: the older shiftworker. The effects of shiftwork on the sleep of shiftworkers are surmised to affect or even reflect (Tepas 1993) the tolerance or adjustment of the shiftworker to an irregular work pattern (Åkerstedt & Torsvall 1981, Monk 1989, Rosa et al. 1990). Through the changes in the sleep-wake cycle, the age of the shiftworker could affect the tolerance or adjustment to shiftwork (Åkerstedt 1990, Härmä 1993, Monk & Folkard 1985, Tepas et al. 1993). The main point of change in relation to age and shiftwork is in fact sleep-related (Härmä 1993). It has been assumed that the effects of age and shift may well be additive, precipitating major sleep difficulties for the individual concerned (Monk & Folkard 1992).

It has been long recognised that older, highly experienced, shiftworkers may become less tolerant to shiftwork in their late 40s and there is some indication that, at least as far as sleep disturbances are concerned, age and experience may both contribute to the older shiftworkers' problems. Several authors have studied the different aspects of the relationship between age and tolerance to shiftwork. Benoit concluded that age appeared to be a major factor for sleep and circadian rhythms, with the 40s as a critical period for sleep disturbances in shiftworker. Day sleep of poor quality was one of the earliest critical symptoms of disadjustment, and middle-aged people seemed to encounter more difficulties in adjusting their sleep after a phase delay than younger workers. These results confirmed that there is no long-term adaptation to shiftwork (Benoit 1980).

The characteristic of morningness is (for all age groups) one of the best predictors of those who are likely to have shiftwork coping problems. Thus the morningness consequence of ageing might itself render shiftwork adjustment difficult. Åkerstedt (1990) found that older age and morningness were related to higher than average problems in adjusting. The increased morningness in older people could result in increased difficulties related to working afternoon and night shifts. On the other hand, they are less likely to have problems with morning shifts (Härmä 1993, Kerkhof 1985).

Härmä et al. (1992a, 1992b) extensively investigated the relationship between age and circadian adjustment to night work. The results indicated that ageing decreased circadian adjustment to nightwork. This change became obvious well before retirement age. Ageing was associated with a decrease in deep sleep, which corresponds mainly with SWS. The authors concluded that, since SWS is crucial for the brain to recover from sleep deprivation, the decrease in SWS after the night shift might be an important mechanism through which ageing decreased shiftwork tolerance.

Koller et al. (1985) found that both young and older shiftworkers sleep significantly less than middle aged during night shifts. The young ones slept less because they did not sleep in advance, the older ones because they could not sleep the day after the night shift.

Meulenbergs and Verhaegen (1982) studied both quantitative and qualitative aspects of sleep in 50-56 year old self-selected shiftworkers. They found that these older shiftworkers got on average nearly an hour less sleep per night compared to day workers.

Åkerstedt and Torsvall (1981) asserted that it has seldom been made clear whether the disturbances caused by irregularity of sleep hours merely reflect the normal deterioration of night sleep as age increases or whether displaced sleep hours exacerbate the effects. In their study, analysis of variance showed that age was, by far, the most important predictor of day sleep difficulties. Also, length of experience of shiftwork and diurnal type (morningness) were rather good predictors. For early night sleep before the morning shift the age trend was reversed i.e. the effects of age on sleep depended on the time of day to which sleep was displaced. It appeared that adjustment to shiftwork did not improve with practice but rather the reverse was found in higher age groups. For night sleep there was a moderate decrease of sleep length and ability to remain asleep but no change of recuperation or ease of falling asleep. For day sleep (after night work) all four variables indicated considerably worse sleep as age increased out of proportion with the moderate deterioration of night sleep. For early sleep (before a morning shift) only premature awakenings showed an increase. In general, reports of premature awakening, medical treatment, and use of hypnotics, but not difficulties falling asleep, increased with age. Their study thus showed that the negative effects of day sleep grew progressively worse with increased age, while those of night sleep were far less affected - early night sleep even showed a reversed trend. This change might make it easier to work schedules that require a phase advance of sleep. Possible explanations offered by the authors for day sleep becoming progressively more difficult are an increase in morningness which could be due to a biological phase advance. Another explanation was the increased tendency for rhythms to desynchronise This finding is all the more remarkable because napping, which is a short day sleep, becomes more easy with older age. And this is frequently explained by more fragile circadian rhythms.

Regestein and Monk (1991) concluded that the increasing intolerance of older shiftworkers to night work might be explained by their weaker internal circadian synchronisation plus their increased morningness tendency. Others have attributed age-related shiftwork intolerance to increased phase lability, i.e. the rate at which the circadian system can re-align to be appropriate to a new routine (Reinberg et al. 1980).

Folkard and Monk (1985) distinguished four factors to account for the increasing intolerance with age: cumulative adverse shiftwork effects, a general weakening of the worker's health, the flattening of circadian rhythms, and the tendency towards sleep fragility and/or morningness. With age, there is a general deterioration in sleep, e.g. there is a rise in number of wakenings per sleep and a reduction of total number of hours slept (Weitzman et al. 1982). Increased morningness is associated with a circadian rhythm phase change. Although the evidence is far from conclusive, it could be that morning types have more problems with sleep after night and afternoon shifts. In general, evening types adjust better. The rhythm amplitude refers to how easily can one 'reset' the circadian clock: a smaller amplitude would make it easier. Next to morning and evening types, the authors also distinguish between rigid and flexible sleepers and between vigorous and languid types. Morning evening type relates to the phase of the rhythm. Rigid or flexible sleepers relates to the stability or lability of the rhythm, and vigorous or languid types relates to the rhythm amplitude. The authors imply that sleep deterioration in combination with the above factors could be sufficient to outweigh any of the positive effects of a possible decreased sleep need.

Kerkhof (1985) mentioned three aspects of age related circadian rhythm change. The most consistent finding was a reduction of rhythm amplitude. This has been predominantly reported for body temperature. There was also evidence of change in temporal order of circadian system: older subjects would have relatively advanced rhythms. This agreed with the increased morningness in older people. Finally, with increasing age, there is a reduced strength of circadian control: greater susceptibility to the occurrence of rhythm disturbance. In a study of the relationship of age to the adjustment of two circadian rhythms in female shiftworkers, Härmä et al. (1990) also found a decrease of amplitude and a tendency to internal desynchronisation with advancing age.

Michel-Briand et al. (1981) studied the pathological consequences of shiftwork in retired workers. They compared retired shiftworkers and retired dayworkers on health outcomes, including sleep. The authors found that the perturbations of sleep during professional life are more frequent in shiftworkers, and still higher in transferred workers, but subside at retirement, marking the effects of ageing. Retired day workers reported increased sleep problems after retirement. They conclude that the results indicate that the retired shiftworkers belonged to a selected and adapted group, likely to recuperate when the causes cease.

Foret et al. (1981) in a frequently quoted study, compared shiftworkers, former shiftworkers, and non-shiftworkers on age, sleep and experience. In their study, increased age resulted in a general worsening of sleep in every situation (working periods, vacation and non shiftwork). Working periods (compared to vacations) results in poorer sleep quality whatever the age. However, this finding was particularly pronounced in shiftworkers over the age of 40. Moreover, in each group, length of service in shiftwork was negatively correlated to sleep quality. Age and shiftwork compounded their effects to the detriment of sleep quality. Foret found that the sleep effects of shiftwork did not carry over to vacations, i.e. deterioration was unlikely to be irreversible. During vacations the only factor affecting sleep quality was age. In most cases shiftwork did not result in permanent deterioration of sleep quality. However, during working periods shiftwork did accentuate the effects of age. In this study, where Foret et al.

considered the effects of age and experience separately, they showed that they were both negative factors. They concluded that increasing age resulted in a general worsening of sleep in all situation considered. Working periods resulted in poorer sleep quality, irrespective of age. The effect was particularly pronounced in workers over the age of 40. In each group, length of service was negatively related to sleep quality, but not to sleep quantity.

Webb et al. (1981) looked at sleep of older persons on shiftwork. In an experiment, 8 women (mean age 46.6) were given a shiftwork sleep routine: pretend night shifts with day time sleep. The group of older subjects showed significant and sensitive sleep responses to shiftwork conditions (day time sleep) similar to those which had been established earlier in younger subjects. Their sleep showed decreased latencies of sleep onset, increased awakenings and a modified timing of REM sleep. In addition there was evidence of early awakening from sleep. Paradoxically, recovery night sleep was severely disrupted

Reinberg et al. (1981) studied tolerance to shiftwork, amplitude of circadian rhythms and ageing. Their hypotheses were that first: fast adjustment (large acrophase shift) to a phase shift would be associated with a relatively small amplitude of circadian rhythms for the oral temperature. Obviously, a small shift of the acrophase would be associated with a large circadian amplitude. Second, a subject's good tolerance to shiftwork over many years would be related to a relatively large amplitude of the oral temperature circadian rhythm. In their study they looked at 20 shiftworkers from an oil refinery. They found that a good tolerance for many years was indeed associated with a large rhythm amplitude in both oral temperature and grip strength circadian rhythms. In addition, a good tolerance and a large rhythm amplitude were neither related to a subject's age nor to the seniority in the shiftwork position (i.e. experience)

Most explanations thus focus on biological change in relation to ageing and shiftwork. Social aspects of intolerance to shiftwork in relation to age have been less systematically considered. The previously mentioned example of the wife of a shiftwork objecting to spending nights alone at home is an example.

3.3.3. Experience

The issue of shiftwork experience in relation to the age effects of shiftwork warrants separate attention. It has frequently been stated that shiftworkers who remain in shiftwork, belong to a self-selected group of people who can tolerate shiftwork. This is often referred to as the 'healthy worker effect', used to explain relatively low levels of problems encountered by shiftworkers (although this could also be a result of shiftworkers habitually underreporting complaints when still in shiftwork, see Spelten et al. 1993). This could incorrectly lead to the conclusion that with increasing experience, problems of shiftworkers reduce and so counterbalance the effects of ageing, as older shiftworkers are likely to be the ones with most experience. However, contrary to what may be expected, experienced night workers do not adapt, sleep longer, and sleep before work (Tepas & Mahan 1989). Åkerstedt (1985) did not think that experience was a major factor in adjustment. Age and lack of rhythm adjustment argue against it. Naitoh et al. (1990) stated that "greater experience on shiftwork schedule has not been shown to be associated with reduced complaints about sleep loss". Increasing experience with shiftwork apparently did not result in adaptation of sleep patterns, since experienced shiftworkers still showed decreased daytime sleep (Rosa 1991).

The most well-known study was conducted by Foret et al. (1981) in which they separated out age and experience. They showed that both age and experience had a negative effect on sleep. The effects were particularly pronounced in workers over the age of 40. They found that older shiftworkers reported poorer sleep and greater use of sleeping pills. More importantly, even within a particular age group, the longer the experience with shiftwork, the poorer the sleep hygiene. Experience did have an effect on sleep quality and sleeping pill use, which is *not* simply a function of increased age. In addition, differences in age and experience, as a combined variable, were found, this did not appear to be a linear relationship. Tepas and Mahan (1989) showed night work/day sleep effects even in experienced permanent night workers who most preferred to work night.

On the whole, studies into the effect of age on shiftwork have demonstrated that both age and prolonged exposure to shiftwork are likely to have a significant role in determining a worker's ability to tolerate shiftwork. It has been consistently demonstrated that at some point over the age of 40 shiftwork becomes very difficult (irrespective of shift schedule worked) (Tepas et al. 1993). The reduction in sleep length is perhaps the most robust finding in the research literature (Tepas et al. 1993). In fact the effects are so consistent and robust that they have led researchers to believe that there should be age restrictions imposed in shiftwork: "one might even suggest that people over 50 years should not be employed on work schedules that require shiftwork" (Tepas et al. 1993).

3.4. Literature summary

The effects of shiftwork on the (day) sleep of shiftworkers were surprisingly similar to the effects of ageing on sleep. Sleep was more fragile: shorter, more easily interrupted, fragmented. This finding has led researchers to assume that the effect of age and shiftwork might well be additive, resulting in even poorer sleep of older shiftworkers. Furthermore, adjustment to shiftwork was found to be limited, making the experienced problems more chronic in nature.

In general, the night shift and the morning shifts caused most sleep related problems. However, older shiftworkers found both the afternoon shift and the night shift, with subsequent day sleep, more problematic (despite increased napping in older people). The morning shift should cause fewer problems with advancing age due to the increased tendency towards morningness in older people.

Problems in adjusting to shiftwork at an older age have not only been associated with sleep but with more problems with shiftwork in general, most notably accumulated negative health effects (see chapter 6). Interestingly, most explanations offered fall within the realm of the earlier distinguished 'biological factors": reduced circadian control, increased morningness, and reduced circadian amplitudes. In the general literature into sleep and ageing, both biological and social factors are mentioned.

Nevertheless, in the shiftwork literature attention seems to focus more on biological factors influencing tolerance to shiftwork. Maybe this has been influenced by the preponderance of studies with male shiftworkers (Tepas et al. 1993). This will be discussed in the next chapter. Here attention will first turn to the data of this study.

3.5. Analysis

The influence of shift system on the relation between age and sleep is investigated in the analysis section of this chapter. Because of its importance for sleep duration and sleep difficulties, sleep need is used as a control variable in all analyses where the influence of these variables on other measures is considered. This refers mostly to the regression analyses reported.

Since all subjects in this study were shiftworkers, it is not possible to compare shiftwork to non-shiftworkers. However, different shift systems can be compared. Two distinctly different shift systems were found in the group of nurses studied: 52% of the nurses worked a permanent night shift and 39% of the nurses worked rotating shifts. Research has shown this to be an important difference in relation to tolerance and adjustment to shiftwork. Frequently significant differences between these two groups were found. In general, rotating shift systems were assumed to result in more stress, less control, less choice, and more problems. For this study, analysis focused on sleep and age related differences between these two groups. For sleep measures, comparisons are restricted to sleep on night shifts and rest days.

3.5.1. Permanent night nurses versus rotating shift nurses

The two groups of shift systems were compared with the use of t-tests[1]. The results, presented in table 3.1, show that permanent night nurses and rotating nurses differed significantly on all variables considered. Permanent night nurses were substantially older, slept less both on night shifts and rest days and reported fewer sleep difficulties between night shifts. Surprisingly, they did report more sleep difficulties between rest days. Their self reported sleep need was somewhat reduced compared to the rotating nurses.

Table 3.1:
Mean values on sleep and age for permanent night and rotating nurses

Variable: mean (s.d.)	Permanent night nurses	Rotating nurses	t
age	38.56 (9.4)	29.15 (7.3)	20.10 ***
sleep duration between			
night shifts	6.50 (1.3)	7.12 (1.7)	7.43 ***
rest days	8.74 (1.2)	9.38 (1.1)	8.37 ***
sleep difficulties between			
night shifts	17.58 (4.3)	20.12 (5.3)	9.72 ***
rest days	14.68 (4.0)	12.48 (3.2)	8.42 ***
sleep need	7.65 (1.1)	7.87 (1.0)	3.59 ***

significant differences: *** p<= 0.001

In addition, differences on other, mostly demographic, variables were considered, using both t-test and Chi-square tests. The results in table 3.2. show that permanent night nurses were significantly more likely to have dependants at home. They were more likely to have a partner and to have chosen their shift system for domestic reasons. They experienced less work-home conflict compared to rotating nurses. In addition, they had worked shifts longer, but worked less hours per week.

[1] More detailed information on a comparison between the two groups can be found in appendix II.

Table 3.2:
Differences between permanent night nurses and rotating nurses on demographic variables

Variable mean (s.d.)+	Permanent night nurses	Rotating nurses	t-test or Chi-square
experience in years	15.47 (8.0)	9.01 (5.6)	t = 16.62 ***
hours per week	30.48 (8.8)	36.69 (4.6)	t = 15.51 ***
work-home conflict	16.17 (5.2)	17.06 (4.7)	t = 2.09 *
morningness	34.31 (6.6)	34.00 (6.1)	n.s.
partner yes/no %	80/20%	58/42%	Chi = 78.7 ***
no of dep. = 0	38.4%	78.3%	Chi = 221.01 ***
domestic reason	4.21 (1.4)	1.61 (1.2)	t = 36.19 ***
gender male/female	6%/94%	8%/92%	n.s.

significant differences: * p<= 0.05, *** p<= .001, n.s.: not significant
+ unless indicated otherwise

3.5.2. Effects of age and shift system on sleep

Regression analysis was performed of age and shift system on sleep duration and quality. The results are shown in table 3.3. Sleep duration was influenced by both age and shift system. For sleep difficulties, no significant influence of age was found, which was already found in the previous chapter. However, shift system did have an impact on sleep difficulties. The results indicate that rotating nurses reported more sleep difficulties during night shifts but less for sleep on rest days.

Table 3.3:
Regression analysis of age and shift system
on sleep: beta weights

Variable	age	shift system	R^2
sleep duration			
night shift	-.143 ***	.106 ***	.109
rest day	-.305 ***	.118 ***	.222
sleep difficulties			
night shift	n.s.	.229 ***	.065
rest day	n.s.	-.251 ***	.079

significant difference: * p <= 0.05 *** p<= 0.001, n.s.: not significant

3.6. Discussion

In this chapter attention was paid to the influence of shiftwork on the relationship between age and sleep. Shiftwork is known for its negative effects on both the sleep duration and sleep quality of the shiftworker. The night shift has most marked effects on the sleep of shiftworkers, followed by the morning shift. With regard to age, research has shown that older shiftworkers were even more likely to experience sleep problems because of the additional age related sleep changes. Sleep of older persons and sleep of shiftworkers has similar characteristics: it is more fragile and reduced in duration and quality. Experience did not seem to counteract age in this respect, arguing for limitations in adjustment to shiftwork. In addition, substantial differences were found between shift systems worked, most notably between permanent night shiftworkers and rotating shiftworkers. Both biological and social factors have been found to explain the effect of shiftwork on the relation between age and sleep, with more emphasis on biological factors, i.e. changes in circadian rhythms.

In this study, only shiftworkers were involved so no comparison between shiftworkers and dayworkers could be made. However, two substantially different shift systems were worked: permanent night and rotating shifts. Analysis showed that the two groups of nurses differed substantially not only on sleep variables but also on demographic variables. Permanent night nurses were older, slept less between shifts and on rest days and experienced less sleep problems on night shifts, but more on rest days. In addition, they were more experienced shiftworkers but worked less hours per week, were more likely to have chosen shiftwork for domestic reasons and were more likely to have a partner and children. They did experience less work-home conflict, compared to rotating nurses. Their reduced sleep duration did not affect their sleep difficulties, confirming the less than straightforward relation between the two variables. Their choice for night work is likely to have influenced both the reduced levels of experienced problems and the lower levels of experienced work-home conflict. In this respect, better adjustment could also explain the differences between the two groups of nurses.

Adding shift system to the regression analysis showed that this variable had a considerable impact on both sleep duration and sleep difficulties. The effect of shift system on sleep difficulties was even more marked than the influence of age. The results confirmed the relevance of adding the shift system component to the model to explain the relationship between age and sleep. The shift system worked clearly affected both the sleep duration and the sleep difficulties of the worker.

It was concluded that shift system needs to be considered in relation to age and sleep. However, because of the substantial differences between the two groups, analyses will be conducted separately for both groups, when looking at the acute and chronic health effects in chapters 5 and 6. In chapter 4, first, attention will turn to the impact of gender on the relationship between age and sleep.

4

THE IMPACT OF GENDER AND GENDER ROLES

4.1. Introduction

Gender has been considered as a factor of influence, both in relation to sleep and in relation to tolerance to shiftwork. Here, first, gender related changes in sleep patterns will be discussed, as well as differences in circadian rhythms and the effect of the reproductive cycle on the sleep of women. Subsequently, gender differences in relation to shiftwork tolerance will be considered. Both biological and social factors are considered in relation to gender differences in sleep and shiftwork tolerance. In the sleep research reviewed here, the emphasis was on biological factors. In the shiftwork literature, social factors have been considered more extensively.

4.2. Gender, age, and sleep

4.2.1. Sleep

The focus of attention has been on differences in sleep pattern and on differences in the development of insomnia complaints between men and women. The most consistent finding is that insomnia complaints have a higher prevalence in women, irrespective of age (Kripke et al. 1979, Mauri 1990). Also, with age, insomnia complaints increase more in women compared to men (Kripke et al. 1979), especially in menopausal women (Kripke, personal communication, Mauri 1990, Tune 1969). The main manifestation of this increase is in increased nocturnal disturbances and reduced sleep efficiency. A figure in the paper by Kripke et al. (1979, fig 2 p.106) even suggests that insomnia complaints double for women over 40. They also found that men who do not report insomnia, reported usually sleeping slightly less than women until age 50. Above age 50, the mean reported sleep duration increased more rapidly among men than among women. Generally, women reported insomnia more than twice as frequently as men.

Rediehs et al. (1990) conducted a meta analysis of all pertinent American papers on sleep in old age with a focus on gender differences and predominantly in relation to sleep quantity. The following conclusions were drawn. There were small to moderate average effect sizes on gender differences in sleep among the elderly. No important gender differences in total sleep time were found, with greater variability in men. Unlike earlier data, a trend was found for elderly men to spend more time in bed. In addition, the small but consistent finding of a longer objective sleep latency in women also contrasted with earlier findings. Men spent more time awake in bed after initial sleep, with women waking more frequently but therefore more briefly, which is puzzling. The inconsistently higher scores on sleep efficiency and sleep maintenance for women were minimally supported by earlier findings. And finally, the tendency for men to have more variability in sleep efficiency was also supported.

In a study into mood and sleep in ageing women, Berry and Webb (1985) found that only two sleep variables, sleep efficiency and latency to the first REM period, were reliably related to daytime moods. The relative paucity of a relation between mood and sleep variables was interpreted as reflecting a general insulation of sleep from day-to-day mood variations.

In his paper of 1969, Tune found that the incidence of nocturnal disturbances increased with advanced age, especially in women. Tune made a point of suggesting the change in the sleep pattern of men could be explained by the absence of occupational pressures, whereas women still have their occupational pressures in the form of domestic tasks. It is suggested that in later years, when social and occupational pressures are reduced, there is a tendency for a polycyclic sleep-wakefulness pattern. In this sample, this would only apply to the males, since the author assumed that the women in his sample did not work. Nevertheless, it was also argued that the increase in sleep disturbance was too gradual to be only caused by the sudden absence of occupational pressure after retirement. Also, despite increased social flexibility, there was a fall in sleep duration in the 70s, testifying perhaps to the severity of geriatric complaints (i.e. a more biological cause). With increasing age, the contribution of naps to the total amount of sleep taken assumed an increasing proportion, particularly in the males. And finally, women's sleep was severely disrupted in menopausal years. On the basis of this study it could be concluded that women have worse sleep quality compared to men (more interruptions, less naps), but the overall sleep amount is similar because men nap more. The influence of reduced occupational pressure and a change in social pattern have more often been mentioned in relation to age-related sleep changes, but have been mainly focused on men. In all, a more behavioural or social explanation was offered for the changes found.

Reynolds et al. (1991b) concluded that healthy ageing was associated with stability of sleep continuity and REM sleep and only a modest decrease in SWS. In this respect, different gender related aspects were found. Women showed better preservation of SWS than men. However and unexpectedly, they also found that 80-year old women showed a decay in sleep maintenance, while 80-year old men demonstrated stability of sleep maintenance, relative to their respective 60- and 70-year old counterparts. Buysse et al. (1993) in their study also confirmed sex differences in sleep patterns among the elderly with elderly men showing weaker rhythmic (circadian) trends than women. Together, these findings suggest that there could well be an age by gender interaction, because the sleep of the elderly is found to be different for older men and women.

4.2.2. Circadian rhythms and sleep

Circadian rhythm differences have been studied with respect to gender differences in sleep. In most studies changes in the temperature rhythm have been studied for obvious reasons: it is fairly easy to research, representative of other rhythms and a frequently used measure, thus increasing possibilities for comparison. With regard to gender differences, the main and most consistently reported finding is a gender difference in temporal organisation: women displayed more morning-type behaviour compared to men (Kerkhof 1985, Moe et al. 1991, Wever 1984).

Wever (1985) found individual differences in internal desynchronisation: under internally synchronised conditions the free running period (tau) of females is on average 28 minutes shorter compared to males. Further, although women are more likely to desynchronise by a shortening of their sleep-wake cycle than men, there is no subsequent difference in the period of their desynchronised free-running temperature rhythms. Hence Wever concluded that the main difference between the sexes is in the intrinsic period of the sleep-wake cycle rather than in their temperature rhythm. Taken together, these findings suggest, according to Wever, that women may be more prone to various rhythm disorders than men, no examples of these disorders were given.

Reanalysing data Wever reported, Monk (1989) found that there was a significant correlation between age and tau (free running period). For women, advanced age was generally associated with a shortening in tau. This is consistent with the morningness finding, because morning types tend to have more phase advanced rhythms which is associated with a shorter tau. The question remained if this has a purely biological basis or whether social aspects could also be of importance. In the literature no reference to possible social influences on morningness was found.

Moe et al. (1991) found several age related changes in the circadian rhythm of body core temperature. First the amplitude of the rhythm declined with ageing but this may have been the result of age related changes in behaviour patterns or amount of exposure to bright light. Second, the free running period was shorter in aged (24.47 hours) versus young (25.05). Third, the effect of age on timing/phase of the entrained subject had been more difficult to discern; there could be gender related differences. In their study, they looked at a sample of 17 women and 14 men and recorded their core body temperature every hour. They found four significant gender differences: the women had, in comparison with the men, an advanced acrophase (49 minutes). This made them more morning types, less variability in acrophase, greater amplitude and higher peak temperature. There was no differences in nadir (minimum temperature). Gender difference in mean temperature seemed to disappear with age, most likely as a result of age related decrease in the mean temperature of women, as male mean temperature remains the same with age. In contrast, the gender difference in amplitude was reversed with age. Since amplitude decreased with age in men this reversal suggests that females experience a much smaller age related decrease than males in this component of the temperature rhythm. This finding is all the more interesting because amplitude changes (i.e. a flattening of rhythms) are one of the main age-related changes. The pattern of gender differences varied considerably from the pattern others have found in young subjects, suggesting that ageing may affect the circadian timing of men and women differently.

Finally, the authors commented on differences found in younger women and men: young women had higher mean temperature and smaller amplitude than young men. However, according to the authors a lot of these differences could be explained by fluctuation of the core temperature across the menstrual cycle; they state that only one study controlled for these fluctuations. Interestingly, Monk et al. (1995) reported finding significantly lower temperature amplitudes for young women compared to either elderly subjects (men and women) or young men. The result surprised them because they had been careful to study the women in the early follicular phase of their menstrual cycle. They thus found advancing age in women to be associated with *enhanced* rhythm amplitude which in this study resulted in having young males as a comparison group. Young females were excluded from the study.

In this context it is noteworthy to mention that Monk et al. (1995) held that the finding of circadian change associated with age, was mainly based on studies in which older women were not studied and may thus be gender-biased. Interestingly, Folkard (1996a) argued that there was also a suggestion that any gender differences in adjustment to shiftwork could also reflect a difference between men and women in the relationships between their body clocks and their sleep/wake cycles. Thus, he claimed, although it is generally assumed that there is no gender difference in the normal (entrained) temperature rhythm or in the period of the free-running temperature rhythm when desynchronised from the sleep/wake cycle, there are differences in both the synchronised free-running period and, perhaps more importantly, in the proportion of time spent asleep, i.e.

the 'sleep fraction' (Wever 1984). In addition, the results from Monk et al. (1995) may even argue against the assumed absence of a gender difference in the normal temperature rhythm. These results then would add to the interesting conclusion that there are more gender differences in circadian rhythms, maybe even specifically related to ageing, than has been assumed.

Finally, there is also suggestive evidence from a large scale survey (Kripke et al. 1979) that gender and age effects may interact in determining the difference in incidence of insomnia between the ages of 40-50. This would suggest that age effects may be more marked in women although there appeared to be no evidence for this. According to Folkard (1996a) most authors have tended to view gender differences in, for example, coping with shiftwork as resulting primarily from differences in social and domestic pressures rather than from any more fundamental difference in the body clock's control of sleep. However, the above results indicate that there may well be mounting evidence that biological or circadian rhythm changes in gender are of importance and need to be examined more carefully, especially in relation to age and sleep (Folkard 1996a).

4.2.3. The reproductive cycle and sleep

Mauri (1990) reviewed the literature on sleep and the reproductive cycle. She found that in general, women of all ages have a higher rate of sleep disturbances than men. Subsequently she looked at the question whether hormonal changes marking their reproductive lives, make women more vulnerable to emotional stress and to concomitant sleep disturbances. Three phases were considered: menstrual cycle, pregnancy, and perimenopause.

With regard to sleep and the menstrual cycle, she mentioned the following Pre-Menstrual Syndrome (PMS) related sleep complaints: insomnia, hypersomnia, tiredness or fatigue, disturbing dreams or nightmares, lethargy, and inability to concentrate. Most cases of hypersomnia occurred in adolescents or young women. There were very few studies available because most studies excluded women during the menstrual phase of the menstrual cycle. Why this was done is unclear according to the author, because there were no consistent findings indicating the necessity of this exclusion.

In sleep and pregnancy, more awakenings and fewer hours of sleep were a common finding. Especially in the third trimester of pregnancy. These changes were mostly caused by physiological discomfort. In early stages of pregnancy, higher levels of sleepiness, more naps and longer sleep were found. After the birth of the baby, different time periods were found for a return to normal sleep.

Perimenopausal women complain of numerous physical symptoms including disturbed sleep. Women experiencing hot flushes tended to have lower sleep efficiency and longer REM latencies than women without these symptoms. Mauri concluded that it is difficult to determine the extent to which hormonal events, that mark the female reproductive life, play a causal role in the production of sleep disturbances. According to Mauri, the available literature is mostly correlational in nature. Therefore, drawing a conclusion about the mechanisms underlying the relationship between hormones and sleep would be premature, because no causal link has been established (Mauri 1990).

In an earlier review of menstrual cycle research, Patkai (1985) concluded that the available evidence indicated that the pre-menstrual and menstrual periods were associated with some negative moods and somatic complaints in a majority of women. The results were, however, conflicting regarding the pattern, incidence and severity of symptoms.

Totterdell et al. (1995) studied the menstrual cycle in relation to shiftwork. Retrospective measures showed an association between the number of nights worked per year and duration of premenstrual, and menstrual problems, and the severity of premenstrual problems. The results suggested that night work may alter some aspects of nurses' psychological experience of the menstrual cycle.

4.3. Gender, sleep, and shiftwork

In shiftwork research increasing attention has focused on the gender of the shiftworker in relation to tolerance to shiftwork. Both social and biological factors have been considered. In studies of individual differences in shiftworkers, gender was frequently mentioned (Härmä 1993). The best studied gender differences are differences in sleep duration and sleep complaints. This may well have been influenced by the inviting nature of sleep measures as an outcome variable in shiftwork research: affected sleep is a major complaint of shiftwork in general and sleep variables have proven to be sensitive markers for the effects of night work (Tepas et al. 1993). However, unlike in the case of sleep research, the role of social factors has been considered more prominently in explaining gender differences in tolerance to shiftwork. The reasons for this different focus may be explained by the reasons women report for working shifts which will be discussed below.

Movements towards increased equality between men and women in the work place have resulted in legislative changes with respect to women and night work. In the United Kingdom, the government abolished all special restrictions for women on night work in 1988, thus giving women access to a wider range of work schedules (BEST 1990, Scott & LaDou 1990).

Concurrently, the composition of the workforce is changing. It is anticipated that the workforce in the Western world will become older and will have an increased participation of women (Scott & LaDou 1990). At the same time, older workers and single and married women with children have been singled out as groups particularly prone to sleep deprivation (Scott & LaDou 1990). Through societal changes (24 hour service society), shiftwork will become increasingly more frequent (Presser 1989). In addition, the ageing workforce may force older workers to remain in shiftwork and more particularly to work the night shift (Tepas et al. 1993). More women are entering the workforce while they stay responsible for domestic work and childcare (Loscocco & Rochelle 1981). The lack of resources and facilities (e.g. childcare, parental leave, money to pay for these facilities) and the absence of substantial changes in gender role patterns has put women in a position in which they have to juggle all these demands. One of the ways in which women seem to try to juggle their increased demands (combining paid work with homework) is through seeking alternative work schedules. Shiftwork and especially night work gives women the opportunity to combine paid work and homecare without having to rely on expensive facilities. Attention for alternative work schedules has also increased from employers' side, often seen as a means of making work more attractive for women. Research results suggest that the combination of the two trends (easier access and juggling of demands) has resulted in an increase in the number of women working shifts (Presser 1986, 1989, 1990).

In her study into shiftwork among American women and childcare, Presser (1986) found a high prevalence of shiftwork among mothers aged 18-44 with a pre-school child: about one out of six of these mothers who are employed full time and about one out of five of those employed part time, work other than at regular daytime hours. Marital status was found to be a determinant in shiftwork status for full-timers, its prevalence being almost twice as high among the unmarried compared to the married. The study showed that married shiftworking women primarily rely on the father for child care. Part-time shiftworking women indicated they were constrained from working more hours because of the unavailability of childcare.

Next to childcare considerations, she also found the salience of economic considerations to be present. For some women, working late hours was the only alternative to being unemployed. For others it was a financial necessity combined with the fact that the hours of work fitted in with daytime family commitments: childrearing. In a later paper, considering advantages and disadvantages of shiftwork, Presser (1990) considers childcare arrangements to be an advantage of shiftwork. However, in a paper from 1988, she contended that in dual earner families, reliance on spouse for childcare is much higher when respondents work nondays rather than days, which may not be a drawback, but which most certainly can complicate home scheduling. She found for example that rotating shiftworkers had more difficulties with childcare arrangements.

Describing more demographic trends, Presser (1989) points to the workplace becoming more flexible and diverse. The growing service sector which influences work schedules and child care management because up to now, childcare is usually day care. Furthermore, there is an increasing number of single-mother households and postponement of the timing of the first births. These trends make it more likely that women will stay in employment and also that they will choose shiftwork as a means of coping. Presently, these women depend on child care provided by relatives: the father and other (mostly female) relatives. Women are more likely than men to give child care as their primary reason for working evening shifts and nights. And when they work part-time this is more likely to involve evening, night and weekend work. Unmarried mothers are less likely than married mothers to work at home. Quoting Christensen

(1988), Presser claims that working at home as the solution to complex and family problems is a "cruel illusion". From the trends she described it seems more realistic to assume that these women can be found in shiftwork.

A review by Loscocco and Roschelle (1991) corroborates the impression that, for women in shiftwork, their domestic commitment is a major issue in relation to their work. It is interesting to note that as early as 1979, Feldberg and Glenn asserted that the very questions posed about employed women often imply that women are affected more by the predispositions associated with their gender roles than by their work experiences. In a review of the literature on quality of work and 'nonwork' life, Loscocco and Roschelle conclude that there is a burgeoning literature which suggests that working women continue to shoulder the major responsibility for domestic work including childcare. In addition, women are far more likely than men to choose jobs which accommodate work with family. Studies have shown that women tend to work part-time, or sporadically, when they have children and that women choose jobs with hours and locations that suit the execution of home responsibilities.

Another issue they raise is how gender, marital status, and family roles combine to influence individuals' perceptions of their jobs. For example, is gender or marital status a more important determinant of work attitudes? There are some implications that gender role is more powerful than marital status. Finally, they confirm that work schedules may affect individuals' ability to cope with the demands of multiple roles. For example, shiftwork may exacerbate interrrole conflict for married couples.

Researchers have emphasised the impact of work on the family, but the family also exerts important influences on the workplace. Evidence of this family-to-work spillover was found in a study by Crouter (1984). Results suggest that women with young children are most likely to report high levels of spillover, in contrast to mothers of older children and to fathers, regardless of their position in the family life cycle.

It is, in addition, likely that workers may limit their involvement in work, or in family life, so that they can better accommodate the demands of the other (Lambert 1990).

Charles and Brown (1981) studied women, shiftwork and the sexual division of labour. The reasons given by women in their group for taking up shiftwork were most commonly that the hours fitted in with family commitments. They concluded that, far from restructuring the family, women work nights within the existing structure and they bear the brunt of the contradiction between women's paid work outside the house and their unpaid work within it. Women as individuals, suffer from the same types of problems as do men as a result of shiftwork but are also subject to added stresses arising from their specific position within the family. This is particularly so for women working full-time shifts that conflict with childcare commitments, such as double-day shifts, or that cause them severe problems even though they permit them to combine full-time work with bringing up a family such as night shifts.

In summary, shiftwork may become more frequent, and women with children and older workers (men and women) are more likely to be found in shiftworking jobs, while they at the same time have been singled out as groups most at risk for sleep deprivation (Scott & LaDou 1990). Therefore, gender and more importantly, gender roles need to be considered in research into shiftwork. Furthermore, the consequences of shiftwork may differ in different stages of women's lives, both as a result of gender and ageing differences in relation to sleep and as a result of differences in domestic demands on women.

To a degree, the changed legislation is the result of research not finding substantial reasons to "deny" women access to night work (Kogi 1990). The initially perceived need to protect women from night work and the increased demands on women raise questions about the effects of shift work in combination with increased demands on women. Research has shown that, first, sleep changes with age. Second, women report more insomnia complaints irrespective of age, and third, women report a more rapid increase of complaints with age. In addition, shiftwork affects the sleep of the worker substantially. This justifies attention to the emanating additional effects of shiftwork on women. The additional social aspects influencing the increased participation of women in shiftwork account for the growing attention to the effect of gender, and more importantly, gender roles.

4.3.1. Gender and gender roles

The focus in research on women in shiftwork has not only been fed by the societal and legal changes described above, but also by research results finding considerable negative effects of shiftwork for women, centring around their sleep (e.g. Gadbois 1981). In all, attention has focused more on the gender role differences as possible explanations for differences between men and women in shiftwork. This could have been caused by the relative paucity in biological gender differences found to account for these differences. The limited findings for a biological base for differences between men and women in relation to sleep and shiftwork have even led some authors to presume that gender differences in shiftwork are mainly caused by social/domestic pressures, which would be more important than any potential biological differences (Monk & Folkard 1985).

4.3.2. Women and nightwork

For many years women have been able to work at night, mainly on the basis of legally exempted sectors of which nursing is a distinct example: the majority of nurses have always been women and night work has always been part of their job. Research has shown that sleep is the most clearly affected area, especially sleep quantity. Because of the double work day for most women, generalising from studies of sleep disturbances in employed men to employed women is problematic (Lee 1992).

It was found that female night workers who are primary care takers of younger children sleep less (on average 1 hour and 20 minutes) compared to their male counterparts and compared to women without children (Gadbois 1981, Oginska et al. 1993). Similarly, women who work night shifts experience more sleep problems when compared to employed women in day time jobs. Lee

(1992) found a higher incidence of sleep disturbance and excessive sleepiness for women working night and rotating shifts, but age and family factors, rather than caffeine and alcohol intake, contributed to the differences in types of sleep disturbances. Use of medication as well as fatigue was more prevalent among older women. Working women, regardless of age, are reported to be more frequent users of sleeping pills and tranquillisers than working men, however, the frequent use of sleeping aids was uncommon in all groups. Women who worked permanent day shifts were older than those on other shifts, particularly the rotating nurses. Rotators had less experience and worked more hours compared to permanent shift workers. Controversy remained concerning the quantity of sleep obtained by shiftworkers. Some researchers have demonstrated longer sleep periods on days off, compared to work days, as found in this study. When incorporating nap time into the total amount of sleep, permanent night nurses had more hours of sleep on work days and days off than women in the other three groups. Although the total sleep time averaged more than 8.5 hours, nurses in this group perceived that they obtained too little sleep. Contrary to findings in male shiftworkers and other groups, use of sleep medications, alcohol, and caffeine did not differ significantly among these groups when controlled for age.

Even when controlling for age, night nurses and rotating nurses had higher scores than day and evening nurses on the sleep disturbance questionnaire. More problems were reported with initiating sleep and maintaining sleep. More younger nurses (regardless of schedule) reported disturbed sleep because of childcare responsibilities and more older nurses reported disturbed sleep due to snoring, sweating, and hot flushes, resulting in different reasons for the same problems when women under 40 where compared to women over 40.

Comparing two matched (for age and occupation) groups of men and women, Oginska et al. (1993) found that men slept more than women especially on afternoon and night shift. These differences were even more striking when related to personal sleep requirements. Women had a lower rating of subjective health and experienced more sleep disturbances. However, after passing the critical decade (40-50) their subjective health generally improved whereas in men the consequent deterioration of health with advancing age was observed.

In a longitudinal study of the effects of shiftwork on the sleep of French nurses, Niedhammer et al. (1994) found that nurses on alternating schedules including night work had more sleep difficulties at the beginning of the study, compared to nurses on permanent shift systems. In addition, sleep difficulties at T1 predicted transfer to day work at T2 and sleep difficulties decreased strongly after this transfer. In all, however, they did find an absence of a link between shiftwork and sleep disorders, which was explained in terms of a self selected group who were able to adapt. The implication is that if sleep difficulties can still be found in an experienced group, there is likely to be a real problem. When shift systems changed to include nights, female shiftworkers reported more sleep disturbances (Costa & Gaffuri 1989).

Using sleep complaints as a marker for maladaptation, Epstein et al. (1990) found that three times more women than men were defined as maladaptive. Next to finding that night workers sleep significantly less than day workers, results showed that female night workers slept least (Dekker & Tepas 1990). The finding that female night shiftworkers slept less than male night shiftworkers can be viewed as a manifestation of the Adaptation Phase of the Austrian model (discussed in chapter 6). During this phase, in many societies, particularly American society, the demands of the family can be intense for working women (Dekker & Tepas 1990). One might also interpret the data as an indication that women are more susceptible to the demands of shiftwork than are men. However, an examination of gender differences in sleep complaints by experienced night workers suggests that just the opposite may be true (Dekker & Tepas 1990) Their findings suggest that it is not nightwork per se that is detrimental to females. Rather the increased sleep difficulties could be due to the fact that females experience the stresses of a greater number of demands upon their time.

4.3.3. Gender role differences

The general finding of increased sleep problems of female shiftworkers has focused attention on possible explanation for this gender difference. This has resulted in an abundant body of research emphasising gender roles rather than just gender. Domestic commitment in relation to women working shifts is a frequently studied area (Spelten et al. 1995). Some of the more prominent results are discussed below.

In a review paper on women and night work, Dirkx (1991) mentioned conflicting demands as one of the most likely causes of differences between men and women. 75% of females in Dekker and Tepas' study (1990) responded positively to doing housekeeping duties versus 15% of all males. Robson and Wedderburn (1990) reported that 59% of married women in their sample said they worked shifts because this fitted with domestic circumstances, while only 13% of the married men answered in this way. This was even more true for women with children (79%, compared with 14% of childless women). Married women showed a stronger preference for permanent night or evening shifts than any of the other groups. The apparent cost for married women working shifts is their reduced social life. In short: women seemed to suffer more from sleep shortage and complain more about difficulties with falling or staying asleep, midsleep awakenings, tiredness, irritability and fatigue accumulation. It was shown however that it is not necessarily married women with children who complain most. The sleep shortage seemed to follow from the fact that working women still bear the primary burden of household duties and childcare. Paradoxically, for many women these household duties are the reason why they like to work in shifts or at night. In several studies, permanent night shift systems induced better results than rotating systems. The permanent night nurses could schedule their sleep and organise their family life according to their work better than could the rotating nurses.

Brown (1982) concluded that women experience the same problems as men on shiftwork. Hoever, women are more likely to use shiftwork as a means to cope with the dual demands of work and family. As a result, shift systems which allow women flexibility to change their hours of work to meet family commitments were experienced much more positively than systems where there was no scope for such control. Other studies have found similar results (e.g. Beermann & Nachreiner 1995).

Tepas et al. (1993) recently conducted an extensive study into the effect of age and gender on the sleep duration of shiftworkers, focusing on shift level. They argued that the general findings regarding shiftwork and sleep length (reduction) have mainly come from samples of male shiftworkers. They found a statistically significant interaction among age, gender, and shift for the workday sleep length of workers on permanent day, afternoon/evening, and night shifts. Sleep length declined with age for both male and female night workers, as well as for male workers on afternoon/evening shifts (but not for female afternoon/evening workers). In addition, female night workers in the 18-49 age range slept significantly less than same age male night workers. Nap behaviour also varied with shift, but age and gender effects did not seem to account for the variance. The results supported the assumption that most night shiftworkers are at risk even though they often give the appearance of being able to tolerate nocturnal work hours. The authors did however conclude that it is not yet clear how age and gender are related to the social, circadian, and environmental factors that influence the sleep length of shiftworkers. The shorter sleep of night shiftworkers has been blamed on circadian effects of daytime sleep, as well as on environmental conditions and social obligations during the day time. Significant differences in the night shift suggest that sleep length for females is strongly influenced by added social burdens. The shorter sleep of these women has been associated with greater family responsibilities (Gadbois 1981). This may explain also, at least in part, the decline in sleep length for females as well as for males in the middle-aged groups, when family responsibilities such as child rearing, are the most prevalent. Results indicated that the self-report sleep length for workers on permanent day, afternoon/evening, and night shift were differentially influenced by age and gender. Unexpectedly, differences in average sleep length between day and afternoon/evening workers in the 40-49 and 50-59 age groups were not found. Why this was not reported in other studies is unclear, however, the authors suggest that those studies did not separate out gender and age. In the present study they did in fact find significant differences between all shift groups when age and gender interactions were not considered. The way in which work schedule, age, and gender interact with social and biological factors and subsequently affect the quality and quantity of a shiftworker's sleep warrants further attention. The gender differences found in this study provide a good demonstration of the complexity of shift system interactions. The sleep length of both male and female night workers decreased as age increased. This difference between genders disappeared after the age of 50.

Cervinka et al. (1981) conducted psychophysiological and psychosocial studies on female night and day workers. On the whole, they found that shiftworkers did not sleep as long as day workers specially during the morning shift, additionally they reported more disturbances in sleep onset. It is remarkable that their sample (N=54 females) was dominated by evening types, because women are more likely to tend towards morningness.

Robson and Wedderburn (1990) showed that there were fairly slight differences in reported sleep between married/unmarried men and women, in their study. Robson and Wedderburn found that young unmarried women complained most about sleep and fatigue, maybe due to their less relying on a daily routine compared to married women. They reported that 59% of married women in their sample said they worked shifts because this fitted better with domestic duties. Shiftwork had an extra attraction because it can be arranged at times that cause least interference with domestic duties. They found fairly slight differences between the reported sleep of the four groups with single women sleeping least when on duty and most when off duty. Single women seemed to have most difficulties with day sleep and single men least.

Saito et al. (1987) found that nurses on an irregular three-shift system felt that shiftwork was unfavourable for their family responsibilities. Nurses gave particular priority to balancing shiftwork with their family responsibilities including child care. It could well have been that some nurses deferred having children until they could prepare the countermeasures to lessen the difficulties in balancing shiftwork with their duties at home. Finally, the attitude of nurses towards shiftwork was significantly associated with their life-stage.

Shamir (1983) looked at some antecedents of work nonwork conflict. In this study, the impact of three work schedule aspects (shiftwork, the length of the workday, and work during weekends and holiday) on perceived work/non-work conflict was considered. It was found that all three aspects were related to experienced conflict. Personal background variables were not related in any way to the level of conflict. Job satisfaction and organisational role conflict were directly related to conflict and moderated the relationship between conflict and work schedule aspects.

Gadbois (1981) concluded that the demands of off-the-job activities tend to take priority over the search for better ways to make up for the sleep deficit. Mothers with young children went to bed later. The travelling time from work to home turned out be longer for mothers compared to single women. A difference of 80 minutes in sleep length was found between unmarried nurses and nurses with two children and this shorter sleep duration was maintained over 7 consecutive working days. The shorter sleep of women with family responsibilities was clearly linked to the organisation of off the job time necessitated by these responsibilities. Premature sleep interruptions for the midday meal were more frequent for women with children (13% unmarried versus 52% for women with 3 or 4 children).

Gersten et al. (1985) looked at age and gender differences in night worker's sleep length and found both. Among night shift workers, females and those over the age of 39 appeared to have sleep deficits which were larger than those of young males.

An earlier quoted study by Härmä et al. (1990) is one of the few studies in which the relations of age to the adjustment of the circadian rhythms of oral temperature and sleepiness to shiftwork was studied in a sample of all female shiftworkers. They found a decrease of amplitude, and a tendency to internal desynchronisation with age. They call their results tentative, leaving ample space for alternative explanations, as mentioned by the authors. Surprisingly, they make no mention of the fact that the results might be influenced by gender factors, i.e. they do not mention possible comparison problems.

In several studies, permanent night shift systems induced better results than rotating systems. The permanent night nurses could schedule their sleep and organise their family life according to their work much better than can the rotating nurses. Folkard et al. (1978) added to this with their study into full-time and part-time permanent night nurses with and without children. Full-timers, who were less likely to have children, were able to make more of a commitment to nightwork than part-timers. Full-timers slept in, took afternoon naps, and experienced better sleep between shifts. Differences in adjustment were reflected in equivalent differences in adjustment of physiological circadian rhythm. Lack of commitment was associated with poorer adjustment in both sleep hygiene and circadian rhythms, which was probably a consequence of social and domestic pressures. Monk and Folkard (1985, p 231) even conclude that "certain of the more recognised individual differences (e.g. sex) can be viewed as being primarily mediated by differences in level of commitment". They define level of commitment as the degree to which shiftworker is willing/able to structure their life around the need to work at unusual hours.

The issue of commitment is becoming more intriguing, because not all studies found the gender effect for women in shiftwork (Dirkx 1991, Estryn-Behar et al. 1990). For example, Epstein et al. (1990) found more sleep complaints for women, but unexpectedly, the profile of the nonadaptive woman was different from the one anticipated: she was young, single without children and with a higher education. Thus the possibility that maladaptation to rotating shiftwork in women is exclusively due to interference with family life could be refuted. Robson and Wedderburn (1990) found that young unmarried women complained most about sleep and fatigue, which was explained by their less relying on a daily routine compared to married women.

Similarly, in two papers seemingly based on the same sample, Beermann and her colleagues found no differences between men and women working rotating shifts under similar job conditions. (Beermann et al. 1990, Beermann & Nachreiner 1995). This study is in itself special because very few studies studied gender differences in comparable work conditions. No gender-related effects of shiftwork could be found using discriminant analysis. They did find gender related unequal distribution of domestic duties. Still, in their cross-sectional study, the 'double burden' for women did not result in more severe psychosocial or subjective health impairments. They did however mention two important reservations which may well have influenced their results: (i) theirs was a relatively young sample (mean age 28 years) and only a few (not specified) females had any long-term experience of nightwork (due to recent legislative changes), and (ii) in Germany, women in the police force get an opportunity to change from working shifts to daywork. This makes it more likely that women, whose domestic duties and working hours are incompatible, leave shiftwork. One could also summarise their results by stating that in a 'neutral' situation, men and women would adapt equally well. Given these reservations, caution in generalising their results seems warranted.

These results do however focus on the earlier mentioned issue of choice and control. The discussion may well move from gender, to gender roles, to adding the influence of choice and control to these two factors. Several authors have commented on the positive moderating effects of choice on negative outcomes of shiftwork (Barton 1994, Brown 1982, Monk & Folkard 1985). Analogous to the 'healthy worker effect' it could be argued that choice could introduce a special kind of 'healthy female shiftworker effect', which may explain some of the seemingly contrary findings in relation to shiftwork and gender.

Finally, it is interesting, that there are numerous studies where no information is provided about the gender of the sample (e.g. Foret et al. 1981, Koller et al. 1985, Michel-Briand et al. 1981) or where a traditional role pattern is assumed (Tune 1969). And despite the time passed, these results are still quoted as equally relevant for the present time. In the case of isolation studies, it can often be assumed that the sample are all of one sex because of the circumstances the subjects are required to live in. In addition, it was found that in explaining results in the case of male subjects often only biological factors are considered. Both biological and social factors in explaining age and sleep differences are mainly mentioned in studies which explicitly focus on gender differences or on all-female samples. Most explanations for gender differences focused on social factors, which may be explained by the very few consistent gender differences which have been found.

4.3.4. Shiftwork and the reproductive cycle

This major area of biological difference between men and women will be reviewed in relation to shiftwork. Although issues pertinent to this area will not be considered in the analyses of this study, it is a relevant area to consider. It is a good example of how gender and gender related issues have influenced the shiftwork debate and general thoughts about women and shiftwork. The main aim of reviewing this area here is to point to the importance and persistent presence of 'beliefs' in the entire gender and gender role discussion.

As will be demonstrated below, a close examination of the results in this area finds very little consistent proof for a definite negative influence of shiftwork on female reproduction. Nevertheless, a common knowledge assumption remains that shiftwork and reproduction are a bad mix. And often studies with tentative results in this area remain to be quoted as supporting this assumption. Without wanting to underestimate possible negative effects of shiftwork for women and more specifically for female reproduction, the standpoint taken here is that there is very little consistent and thorough research done in this area which has managed to establish a negative link between shiftwork and reproduction. In addition, the question could be raised if there really is a need to 'prove' that shiftwork and reproduction is an alarming combination. Do we really need 'hard' facts on increased abortion rates and reduced pregnancies ratios in order to allow pregnant women the possibility to opt out of shiftwork or nightwork? Maybe the well-established fact that pregnancy puts additional demands on a woman, and for example severely reduces her sleep duration and quality, is in itself reason enough to safeguard women from the additional burdens of shiftwork or nightwork when they are pregnant. But this standpoint could of course easily be classified as a 'belief'. And the issue of BEST (1990) shows that sensible guidelines can be formulated without the need for hard evidence.

Differences related to the reproductive cycle are probably the main potential biological gender difference to consider. Reading the literature, the impression holds that it is a controversial area of research. As mentioned earlier, nightwork restrictions for women were abolished more than anything because research could not come up with objections (Kogi 1990). Consequently, there are also no restrictions for pregnant women in relation to shiftwork and or nightwork. However, some alarming findings have been reported and are frequently quoted (e.g Uehata and Sasakawa 1982). Unfortunately, the results of some these studies are questionable, as will be argued below. Because of the risk involved, safeguarding pregnant women remains an important issue in research and policy making. A good start could be made by more carefully considering reported research results.

In general, shiftwork has been considered a potential risk factor because this type of work may disturb normal body functions and hormonal balance. Shiftwork may also interfere with possibilities for cohabitation, and it has been considered a possible risk factor in reproductive failures such as preterm delivery, low birth weight, and spontaneous abortion. Studies also revealed that the secretory patterns of cortisol, prolactin, and testosterone are affected by shiftwork, both the serum concentration and the amplitude of the rhythmical wave of these hormones were decreased which may have implications for reproduction (Bisanti et al. 1996).

A frequently quoted paper is a paper by Uehata and Sasakawa (1982). A cross-sectional self report questionnaire study was conducted into fatigue and maternity disturbances of night work women. Their results in relation to reproduction were the following. First, rates of menstrual irregularity and painful menstruation were higher in night working women. Second, the experienced rates of pregnancy and delivery at the same ages within the past two years were lower in night working women, whose abortion rates were higher. The rates of stillborn infants were also higher in night work women. And third, night working women complaining of painful menstruations had high rates of abortion and pregnancy toxemia. Subsequently they conclude that the results suggest that it is necessary to restrict the working hours of night work women and promote measures to protect their maternity. However, careful consideration of the data reported in the paper, indicated that some caution may be required regarding their conclusion. First, on the basis of a cross-sectional study, they link night work to menstrual problems, and to pregnancy problem (in combination with the third point). It could well be that there are other reasons for the menstrual problems in night working women that were not considered in this study. If anything, on the basis of this study it cannot be concluded that it is the nightwork itself which causes the problems. Moreover, the nightworking women they mention are rotating shift workers. This is important because other studies (see below) reported more reproduction related problems for rotating workers compared to permanent night workers, considerably changing the focus of the cause of their problems: from night work to potential stress related problems in relation to the constant changing shift pattern. The explanation offered is that such systems possibly give less opportunity to recover. Which was incidentally also an explanation suggested to account for gender differences in increased sleep difficulties. It was argued that the increased sleep difficulties could be due to the fact that females experience the stresses of a greater number of demands upon their time (Dekker & Tepas 1990).

Their second point calls for questions about socio-economic circumstances and the wish to become pregnant, questions that have not been addressed in this study. This makes the result difficult to interpret, let alone attach farfetched conclusions to. The higher abortion rate is alarming, but their study does not clearly link this to night work (as opposed to rotating shiftwork for example). It is not clear how this question was phrased (miscarriage, abortion, spontaneous or not) and there may have been cultural factors to consider. Moreover, the lower pregnancy rate and the higher abortion rate are the only two significant findings in a longer list. No significant differences were found for: the number of normal pregnancies, toxemia of pregnancies (see also the third point below), normal deliveries, premature deliveries, still births, dystocia and a low birth weight.

The reported higher rate of stillborn infants in night working is not a significant result and interestingly enough, a subsequent table shows that of the 3 still births, 2 happened to women with reported regular menstrual cycles and only 1 to a woman with an irregular cycle.

The third point again refers to non-significant results (see their table 4). And since the association is with pain and not with night work, connections with night work are arguable. In this respect a table showing comparable statistics for day working women would have been more insightful.

Scott and LaDou (1990) associated a low birth weight with rotating shiftwork, more so than night work (p. 281) which may point to another variable in relation to their other results. In general the 'common' explanations for adverse pregnancy outcomes are: stress, diet, smoking and drinking.

Nurminen (1989) studied shiftwork, foetal development and course of pregnancy. This paper quoted several international studies which looked at shiftwork and pregnancy. These studies are briefly summarised below. Both a Japanese (Uehata & Sasakawa 1982) and a Canadian (McDonald et al. 1988, in Nurminen) study were reported in which a higher rate for spontaneous abortion was found. A French study (Mamelle et al. 1984, in Nurminen) found shift and night work to be associated with preterm delivery. With regard to the latter result, it should however be noted again that this occurs in general more frequently in working women, irrespective of job type. The results depended on the comparison group taken. However, another French study (Saurel-Cubizolles & Kaminski 1987, in Nurminen) did not find a relation between night work and preterm birth or low birth weight. The Canadian results were further analysed and suggested that shiftwork (rotating, irregularly changing) retarded foetal growth and increased the risk of preterm birth. In this study no clear evidence for a risk of shiftwork was found. It was concluded that some evidence of adverse effect of shiftwork was found, especially in relation to rotating shift work or irregularly changing work schedules. However, the results were inconsistent. The question remains, whether shiftwork negatively influences the course of pregnancy, and the health of the foetus. It is also not clear what the possible mechanism behind a negative influence could be: is it the irregularity, or night work or work circumstances e.g. noise or chemical hazards (Scott & LaDou 1990).

Infante-Rivard et al. (1993) studied pregnancy loss and work schedule during pregnancy. In this study, the work schedule of women with a miscarriage (331) and 993 pregnant women matched on gestational age were compared. It was found that the risk of miscarriage was four times higher among women with fixed evening work schedules in comparison with women on a fixed day schedule and more than twice as high among women on a fixed night schedule.

Even though more research is needed, they conclude that their findings are important enough as they stand.

A careful study was reported by Bisanti et al. (1996). They conducted a European multicenter study into shiftwork and subfecundity. They found a difference in time to get pregnant between shiftworking and non-shiftworking women. When controlling for a number of variables (age, smoking etc), they still found an odds ratio of 2.0 which they describe as small but consistent. No association of menstrual disorders with shiftwork was identified. i.e. this could not explain the increased odds ratio. Nor did the reported frequency of sexual intercourse seem to be affected by the shiftwork status of the couples. Smoking and previous use of oral contraceptives were strongly linked to shiftwork and this fact could involve other unmeasured factors of relevance for subfecundity. In general, no explanation for the increased odds ratio was found. The association was only found for shiftworking women. Whether or not men worked shifts did not influence the time to a planned pregnancy. They concluded that shiftwork is only a risk indicator and thus more relevant in some situations than others. Should shiftwork play a role in subfecundity, it is most likely a temporary one: it would have little impact on the ability to obtain the desired family size but it could rather be of importance for the ability to time the pregnancy at the desired moment.

It is important to note that in this last carefully controlled and conducted study no evidence for a reduced chance to get pregnant was found. If anything, evidence may well point in the direction of the irregularity of shiftwork and not the night work per se which may be at the root of the problem. This explanation would then be similar to explanations offered for increased sleep difficulties (e.g. Dekker & Tepas 1990, see above).

Finally, in the journal in which the Infante-Rivard study is reported, an editorial was written in relation to this study and the area of research in general. The reservations against research results, plus related implications regarding reproduction and shiftwork, are probably best voiced in this editorial. Here, Pastides (1993) pointed to confounding factors in this type of research. Socio-economic status, age, uterine abnormalities (relevant to the Infante-Rivard study) and coffee consumption during pregnancy are all confounding factors. Then there is the nature of shiftwork compared to day work. Shiftwork is more likely to be more manufacturing work with attendant risks of lifting standing chemical and radiation exposures. Since most of these factors are either directly or indirectly related to spontaneous abortion, confounding is a concern. Pastides concluded that, nevertheless, an important issue was raised because there is no policy for pregnancy and shiftwork.

4.4. Literature summary

In summary, research has found fairly consistently that women who work shifts sleep less compared to men. Gender differences in sleep quality have been less consistently found and have led to assumptions about gender roles, rather than gender per se. Subsequently, it has been found that women with young children do indeed sleep less and frequently report more sleep problems. Attention has focused on choice in the shift system worked. It appeared that women who had chosen to work a particular shift system were more likely to report fewer problems, even if they did report reduced hours of sleep in comparison. It was especially found that women who work permanent night shifts (often a personal choice) had less problems and showed more commitment towards their work hours, then do rotating shift workers.

In addition to the more social factors found in explaining gender differences, there seems to be increasing evidence that biological or circadian factors may well be of more importance than has been assumed to date. Therefore an interaction between age and gender, relevant to the situation of the female shiftworker may well be necessary to consider. The nature of the interaction may be complicated. Kripke et al. (1979) for example found increased insomnia complaints in middle aged women, related to the menopause. However menopause is more likely to start at 50 rather than 40, making this a less than plausible explanation. Monk et al. (1995) argued that men and women age differently in circadian terms, and concluded that women seemed to do better.

With these less than conclusive results in mind, attention will now turn to the influence of gender on the relation between age and sleep for the nurses in this study.

4.5. Analysis

The influence of gender on the relation between age and sleep is investigated in the analysis section of this chapter. The following research questions are addressed:

(i) is there evidence of gender (role) differences on the relation between age and sleep?

(ii) what is the combined influence of gender (role) differences and shift system on the relation between age and sleep?

4.5.1. Gender differences

Most respondents in this study are women (1405 women versus 115 men), making it a biased comparison. Therefore, variables measuring gender role differences will be added to the analyses. The three major aspects relevant in relation to the literature can be summarised as: children, choice and conflict. The relevant variables in this study are respectively: the number of persons that need looking after by the respondent, choosing shiftwork on domestic grounds, and work-home conflict. The first two variables were measured with single questions, the latter variable was measured with the use of a 6 item work-nonwork conflict rating scale (Shamir 1983). A higher score indicates more conflict. A fuller description of the questionnaire can be found in appendix I.

It should be noted that this questionnaire was only included in the Follow-Up study and therefore was completed by a reduced sample (N=648 versus 1532 for the SSI, see appendix II). Comparisons between the two groups (SSI and Follow-up) showed that the groups were very comparable. The nurses in the follow-up sample were only more likely to suffer more problems, especially the permanent night nurses. This was not considered to be a major problem in relation to the analyses for this thesis, however, given the results, it is interesting to keep this in mind (see appendix II). In this chapter, analyses including work-nonwork conflict will be conducted separately, and in addition to the main analyses.

First, the analysis focussed on gender differences for sleep and age, and with respect to demographic variables. Hardly any significant gender differences on sleep were found as can be seen in table 4.1. Men slept less between morning shifts and reported fewer sleep difficulties between night shifts. Similarly, few differences were found between the two groups on a number of demographic variables. Table 4.2. shows that men were less likely to have chosen shiftwork for domestic reasons and that men worked more hours per week.

Table 4.1:
Mean scores for sleep and age for men and women.

Variable: mean (s.d.)	Men	Women	t
age	33.43 (8.8)	33.20 (9.5)	n.s.
sleep duration between			
morning shifts	6.92 (0.9)	7.21 (1.0)	2.59 *
afternoon shifts	9.10 (1.5)	9.25 (1.3)	n.s.
night shifts	6.90 (1.6)	6.88 (1.6)	n.s.
rest days	9.02 (1.1)	9.16 (1.2)	n.s.
sleep difficulties between			
morning shifts	17.68 (3.8)	17.96 (3.8)	n.s.
afternoon shifts	14.96 (3.0)	15.30 (3.5)	n.s.
night shifts	17.64 (4.8)	19.18 (5.1)	3.14 **
rest days	12.89 (3.5)	13.14 (3.6)	n.s.
sleep need	7.58 (1.1)	7.78 (1.1)	n.s.

significant differences: * p<= 0.05, *** p<= .001 n.s.: not significant

Table 4.2:
Differences between men and women
on a number of demographic variables:

Variable: mean (s.d.)+	Men	Women	t-test / Chi-square
dependants = 0	65%	61%	n.s.
domestic reason	2.11 (1.5)	2.67 (1.8)	t = 3.58 ***
experience in years	11.27 (7.6)	11.84 (7.4)	n.s.
hours per week	37.68 (4.6)	34.00 (7.4)	t = 7.70 ***
work-home conflict	15.93 (4.9)	16.77 (5.0)	n.s.
morningness	34.83 (6.3)	34.40 (6.3)	n.s.
partner: yes %	64%	67 %	n.s.
shift system=pn	35%	43%	n.s.

significant differences: * p<= 0.05, *** p<= .001 n.s.: not significant
+ unless indicated otherwise

4.5.2. Effects of age, gender and gender roles on sleep

Regression analysis was performed to look at the impact of age, gender and gender role differences on sleep duration and difficulties, controlling for sleep need. Table 4.3.a and 4.3.b. show the results. Age still is of importance, more strongly related to sleep duration than to sleep difficulties. Gender had a less strong impact and was only related to increased sleep difficulties on night shifts for women. Various gender role aspects have an additional impact on sleep duration and on sleep difficulties.

Table 4.3.a:
Regression analysis of age, gender and gender roles on sleep: beta weights

Variable	age	gender	no of dependants	domestic is reason for shiftwork	R^2
sleep duration between					
morning shifts	n.s.	n.s.	n.s.	n.s.	-----
afternoon shifts	-.217 ***	n.s.	-.209 ***	-.086 *	.220
night shifts	n.s.	n.s.	-.210 ***	n.s.	.148
rest days	-.252 ***	n.s.	-.234 ***	n.s.	.279
sleep difficulties between					
morning shifts	-.086 *	n.s.	n.s.	n.s.	.012
afternoon shifts	n.s.	n.s.	n.s.	n.s.	-----
night shifts	-.068 *	.086 **	.150 **	-.220 ***	.054
rest days	.106 **	n.s.	.089 *	.124 **	.056

significant difference: * $p <= 0.05$ ** $p <= 0.01$ *** $p <= 0.001$ n.s.: not significant

Table 4.3.b:
Regression analysis of age, gender and gender roles (adding work-nonwork conflict) on sleep: beta weights

Variable	age	gender	no of dependants	domestic is reason for shiftwork	work-nonwork conflict	R^2
sleep duration between						
morning shifts	n.s.	n.s.	n.s.	n.s.	n.s.	-----
afternoon shifts	-.232 ***	n.s.	-.210 ***	n.s.	n.s.	.218
night shifts	n.s.	n.s.	-.210 ***	n.s.	n.s.	.136
rest days	-.282 ***	n.s.	-.250 ***	n.s.	n.s.	.303
sleep difficulties between						
morning shifts	n.s.	n.s.	n.s.	n.s.	.179 **	.038
afternoon shifts	n.s.	n.s.	n.s.	n.s.	.266 ***	.059
night shifts	n.s.	.108 *	.142 **	-.180 **	.172 ***	.078
rest days	.159 **	n.s.	.089 *	.163 **	.162 **	.093

significant difference: * $p <= 0.05$ ** $p <= 0.01$ *** $p <= 0.001$ n.s.: not significant

The presence of dependants had a strong impact on the sleep duration of all sleeps considered, with the exception of the morning shift: having more dependants was related to reduced sleep duration. The explained variance is considerable, especially for rest day sleep duration. Interestingly, the impact of dependants on sleep difficulties was different. Only an effect for the night shift and rest day sleeps was found. Here, the presence of dependants resulted in less sleep difficulties.

Choosing shiftwork on domestic grounds did not affect sleep duration and had different effects on sleep difficulties: less problems on the night shift, more on rest days.

Finally, work-nonwork conflict had no impact on reported sleep duration. However, it did have a considerable impact on sleep difficulties: more sleep difficulties was associated with more work-nonwork conflict, for all sleeps considered.

4.5.3 Combined effects of gender (role) and shift system

Shift system was added to the previous regression analysis to look at the combined effects of shiftwork and gender, which are both moderator variables in the model we are developing. This comparison is restricted to sleeps on night shifts and rest days. The results are presented in table 4.4.a. The variable shift system has a clear impact on sleep difficulties. Rotating shift nurses reported more sleep difficulties for the night shift, but less for rest day sleeps. However, explained variance remained low. The addition of work-nonwork conflict in table 4.4.b. does not change the impact of the variable shift system.

Table 4.4.a:
Regression analysis of age, gender, gender roles and shift system on sleep: beta weights

Variable	age	gender	no of dependants	domestic reason shiftwork	shift system	R^2
sleep duration between						
night shifts	-.107 **	n.s.	-.215 ***	n.s.	n.s.	.151
rest days	-.270 ***	n.s.	-.225 ***	n.s.	n.s.	.294
sleep difficulties between						
night shifts	n.s.	.077 **	.161 ***	n.s.	.227 ***	.081
rest days	n.s.	n.s.	.089 *	n.s.	-.227 ***	.084

significant difference: * p <= 0.05 ** p <= 0.01 *** p<= 0.001, n.s.:not significant

Table 4.4.b:
Regression analysis of age, gender, gender roles(adding work-nonwork conflict) and shift system on sleep: beta weights

Variable	age	gender	no of dependants	domestic reason shiftwork	work-nonwork conflict	shift system	R^2
sleep duration between							
night shifts	n.s.	n.s.	-.258 ***	n.s.	n.s.	n.s.	.140
rest days	-.315 ***	n.s.	-.218 ***	n.s.	n.s.	n.s.	.342
sleep difficulties between							
night shifts	n.s.	.099 *	.186 **	n.s.	.184 ***	.237 **	.109
rest days	.133 *	n.s.	n.s.	n.s.	.177 ***	-.380 ***	.160

significant difference: * $p <= 0.05$ ** $p <= 0.01$ *** $p <= 0.001$, n.s.: not significant

4.6. Discussion

The influence of the second moderator variable in this study, gender, was investigated. The influence of this variable on the relationship between age and sleep was considered. With respect to sleep it has been found that women report more insomnia complaints than men. Women reported increased nocturnal disturbance and reduced sleep efficiency. Given the sleep pattern changes related to age, there may well be an interaction between gender and age. For gender differences, both social and biological causes have been suggested. Social differences are for example related to differences in life style. From a biological point of view, there is some indication that there are differences in the ageing of the circadian rhythms between men and women. Reproduction and its related life phases of women also influence the sleep pattern and quality of women. The dramatic increase in sleep complaints of women over the age of 40 is often related to menopausal changes (Kripke, personal communication).

Gender differences in the effects of shiftwork on the sleep of the worker have also been found. Reduced sleep duration for women in shiftwork is the most substantial finding. Very few substantial biological gender differences were found that could explain these differences, although recent research may well have found more indications for biological gender differences, especially in respect to ageing. Possibly as a result of the limited biological findings, more emphasis has been laid on social factors in explaining the differences found, i.e. reasons women have for choosing shiftwork which are often related to their domestic commitment. This changes the focus from gender to gender roles. It may well not be gender per se but more the roles which are traditionally attached to being a woman: raising children and other domestic commitments. This could also explain less consistent findings in sleep quality differences which may be influenced by differences in choice for shiftwork. With the increased participation of women in (shift)work and an ageing workforce, additional attention for both factors in relation to sleep is warranted.

In the previous chapter, attention was paid to shift system in relation to sleep and age. Here, gender was analysed. The gender comparison was hindered by the unequal group sizes in the sample: 1405 women versus 115 men. Possibly influenced by this size difference, only few gender differences were found: men slept less on morning shifts and experienced fewer problems related to night shift sleep. In addition, they were less likely to have chosen shiftwork to fit in with their domestic commitment and worked more hours per week. Next to gender, three variables related to gender role were also considered: children (the number of dependants), choice (reasons for working shifts), and conflict (experienced work-nonwork conflict).

Regression analysis showed that, next to age, the number of dependants had a clear impact on sleep duration of the afternoon and night shift and on sleep duration of rest day sleeps. Sleep difficulties were less strongly influenced by the number of dependants. An effect was only found for the night shift and for rest days. Contrary to the influence on sleep duration, here the presence of dependants resulted in less sleep difficulties. Again this result adds to the notion that sleep duration and sleep difficulties are not directly related to each other.

Domestic commitment as a reason for shiftwork did influence sleep difficulties for night shifts and rest days. This may have been a confounded result. Earlier, it was shown that permanent night nurses were more likely to have chosen shiftwork for domestic reasons. This probably explains the influence on sleep difficulties for night shifts and rest days because these are the only two relevant shift variables for this group. Interestingly, domestic grounds for working shifts are associated with fewer sleep problems during night shifts, but with more sleep problems on rest days. Explained variance was low for sleep difficulties, but higher for sleep duration.

Work-nonwork conflict had a clear impact on sleep difficulties: more conflict was associated with more sleep difficulties for all sleeps considered. Here no indication of a confounded result was found despite the fact that the rotating nurses experience significantly more work-nonwork conflict, compared to permanent night shift nurses.

Finally, shift system was added to the regression analysis. Sleep difficulties were more strongly related to this variable than sleep duration. Also, shift system was now no longer related to sleep duration but only to sleep difficulties, indicating (and confirming) that gender role factors are strongly related to the shift system worked. In all, these variables explain a reasonable percentage of the variance for sleep duration. Less variance was explained for sleep difficulties. This may have been affected by the substantial differences between the two groups of nurses, since only results for the night shift and for rest day sleeps were found. Because of the impact of shift system on sleep and because of the substantial differences between the two groups, analyses in the next chapters will be conducted separately for permanent night nurses and rotating shift nurses.

Following the results of this and the previous chapter, it was concluded that, in this study, both shift system and gender roles need to be considered in relation to age and sleep. Having considered the relationship between age and sleep and the influence of moderating variables, attention will now turn to possible effects of the relationship between age and sleep. First, in chapter 5, acute effects of the found relationship between age and sleep will be considered. In chapter 6 possible chronic effects will be considered.

5

ACUTE EFFECT:

REDUCED ALERTNESS[1]

5.1 Introduction

In the previous chapters, attention has concentrated on possible *sources* of reduced sleep quantity and quality: age, gender roles, and shiftwork. In this and the next chapter, attention will turn towards the other end of the process, i.e. what are the *effects* of a sleep deficit. Effects of sleep loss can be divided into immediate or acute effects, and long-term or chronic effects. Acute effects are a direct result of previous sleep loss, compared to the more chronic health and well-being effects, which build up over time as a result of prolonged exposure. In this chapter the major acute effect of a sleep deficit will be considered: reduced alertness or sleepiness.

In the literature sleepiness and alertness are seen as two ends of the same continuum. Sleepiness or reduced alertness is an inevitable and immediate consequence of sleep loss and is seen as the most prominent acute effect of sleep loss (Johnson 1992). The terms sleepiness and reduced

[1] With special thanks to Dr. E.J.W. van Someren for conducting and explaining the cosinor analyses for this chapter.

alertness are used to refer to the same state and will be used interchangeably in this text.

In the literature review section, attention will be paid to alertness as a circadian rhythm and to on shift alertness of shiftworkers. Because of the composition of the sample in this study, the literature review will be restricted to shiftwork, age and gender. Performance measures were not included in the study, attention for this vast area of research will be limited.

In the analysis section, alertness scores for various groups will be looked at in more detail. Permanent night nurses and rotating nurses will be considered separately, and age and gender role differences will constitute the various groups.

5.2. The circadian rhythm in alertness

How alert or sleepy a person feels varies over a 24 hour day (Folkard et al. 1985). In chapter 2, attention was paid to the circadian nature of sleep: sleep has an underlying circadian rhythm component. Equally, alertness is known to have a circadian component: a regular approximately 24-hour rhythm, which influences the regulation of how alert or sleepy we feel. The most distinct illustration of this 24-hour regulation is the fact that we feel less alert and find it more difficult to concentrate at night. Another well-known instance of a period of reduced alertness is the so-called post-lunch dip, even though there is reasonably good evidence that this dip is only partially related to actual food intake (Folkard 1996b).

5.2.1. The importance of alertness as a circadian rhythm

Where sleep is a pronounced physiological process with the ability to objective recording through sleep laboratory studies, alertness is more clearly a psychological process, which can only be subjectively rated. Alertness is thus an important variable. Folkard and Åkerstedt (1992) even state that the circadian rhythm in subjectively rated sleepiness or alertness is probably the most powerful and replicable of all rhythms in psychological processes. Equally, the significance of the alertness rhythm has been underlined by the relationship between alertness and performance, which has received a lot of attention in research. In relation to work, reduced alertness can be both a safety and a financial risk (Phillips et al. 1991). Of equal importance is the fact that alertness ratings have been viewed as exponents of circadian adjustment. In the case of shiftworkers for example, they have been used as an indication of how well adjusted the shiftworker is to the shift worked. The circadian rhythm of alertness adjusts in a similar way to that of body temperature, i.e. rather slowly (Kerkhof 1985). A robust circadian rhythm is associated with sleepiness at night and alertness during the day (Monk et al. 1996).

5.2.2. A model for predicting alertness

An elaboration of alertness as a measure of circadian adjustment is that alertness ratings may be able to provide an estimation of an individual's circadian phase (Folkard et al. 1995). Folkard and Åkerstedt (1987, 1989, 1992) have, for some years, worked on the development of a model of the regulation of alertness-sleepiness. Their aim is to be able to predict alertness at any given point in time and on any given sleep-wake cycle. Borbély (1987) considered sleep to be largely dependent upon two processes: process S (homeostatic build up of sleep over a period of wakefulness) and process C (a circadian component of sleep propensity). In a similar manner, Folkard and Åkerstedt have developed their model. In view of its similarity to Borbély's hypothetical function, they even use the terms Process S and C. The first, process C, is a pure sine curve that reflects the endogenous component. As such, the phase of this sine curve is unlikely to be affected by occasional variations in the timing of sleep, but may be affected by habitual sleep time. The second, process S, reflects sleep need (or more strictly the inverse of sleep need), which is minimal on awakening from a normal sleep, and builds up linearly as a function of the logarithm of hours awake. The third, process W, reflects the fact that people take some time to wake up properly, and takes the form of a deviation from Process S that decreases linearly as a function of the logarithm of hours awake, and ceases about 3 hrs after awakening. Both these latter processes are 'set' by the time of awakening and are assumed to be entirely exogenous in origin.

Several problems were signalled with the model, which have resulted in a further refinement of the model. Nevertheless, the three mathematical functions in the original model of the variations over the day, each already accounted for over 95% of the relevant variance in the data on which it was based (Folkard & Åkerstedt 1992). The model provides a significant contribution in establishing the importance of alertness as a psychological circadian rhythm.

5.2.3. Alertness and performance

Sleepiness or reduced alertness slows an individual down and as such affects performance. This could be a financial and safety hazard and is relevant to the situation of the shiftworker (Phillips et al. 1991). No performance measures were included in this study, therefore this aspect of alertness will not be considered in great detail. By way of an illustration of the many aspects of this relationship, results from a few studies will be summarised below.

Neylan and Reynolds (1991) found that, for example, rotating shiftworkers who often complained of sleepiness had been shown to have less productivity, greater job-related accidents, and greater incidence of medical illnesses. Performance related effects vary: for different tasks, different effects were found. In this respect, Phillips et al. (1991) pointed to the importance of motivation to overcome sleepiness.

Roehrs et al. (1990) studied performance differences between alert and sleepy individuals (not on shiftwork). During the day sleepy subjects performed more poorly than alert subjects on divided attention and vigilance performance tasks. Sleepy subjects showed higher levels of anxiety than alert subjects did. The data were interpreted as indicating that the sleepy subjects had a sleep debt due to chronic sleep restriction. Sleepy subjects had more efficient sleep, suggestive of the existence of a chronic sleep debt. An important question is whether the sleep debt of the sleepy individual is due to reduced quantity of sleep (i.e. a voluntary habitual restriction of sleep time) or reduced quality of sleep. They considered the most parsimonious explanation to be that the sleepiness is the result of a habitual restriction of sleep time relative to sleep need, which is the case in the situation of shiftworkers.

For shiftworkers a clear performance decrement was found for the night shift, during the early hours of the morning, (around 03:00 hours). Secondly, there was clear evidence of a secondary 'dip' in performance measures shortly after 12:00, with performance falling below average at 13:00 and 14:00. This is often at the end of the morning shift and the start of the afternoon shift (Folkard 1996b).

Anderson and Bremer (1987) considered the impact of sleep onset on subsequent reported sleepiness on the job. No significant differences were found between early-onset and late-onset sleepers in reported sleepiness on the job. The reported sleepiness on the job of short sleepers was significantly less than that of long sleepers on both day and night shifts. This difference was explained in terms of a hypothesised effect of long sleeping on circadian rhythms. Social factors (such as the presence of children) appeared to explain the shorter sleeping periods of some workers.

Circadian rhythms in the efficiency of human performance have been related to an underlying circadian arousal rhythm (Monk et al. 1983). This arousal rhythm has been considered to be the inverse of sleepiness, and would closely parallel the circadian core body temperature rhythm. Subjective indications of arousal, specifically subjective alertness ratings, should therefore exhibit a circadian rhythm which is closely parallel to the temperature rhythm. However, a review of the literature (Folkard in Monk et al. 1983) has suggested that this may not be the case. Monk et al. (1983) showed a reliable and significant difference in acrophase (temperature 18:07, alertness 15:56) between the two rhythms. In addition, a highly significant time of day effect was demonstrated with alertness peaking at 15:00 and temperature at 21:00. In a free-running experiment, a significant correlation did emerge between the period and peak of alertness, indicating that the longer the free-running period, the later the peak in alertness occurred in the waking period. The results indicated that the peak of the subjective alertness rhythm was phase advanced relative to the peak of the temperature rhythm. This phase difference was preserved, even during non-entrainment.

5.2.4. Three concluding remarks

Interrelated nature alertness, sleep-wake cycle, and performance

Although the link between alertness and the sleep-wake cycle and a performance rhythm is clear, there is also enough evidence to support the assumption that the alertness rhythm is a rhythm independent of the other two (Åkerstedt 1991, Folkard et al. 1985, Folkard 1996b, Phillips et al. 1991). This can be illustrated by the fact that people who work at night can feel reasonably alert despite the sleep-wake cycle telling them to sleep. In addition, there are situations known where people would report feeling alert when they perform quite badly, e.g. car drivers who caused an accident at night, which could be attributed to lack of concentration, may still have reported that they felt reasonably alert.

Social factors versus biological factors

According to Folkard (1996b), it is only recently that studies have examined the impact of social factors on safety measures (related to alertness). Rather more studies have looked at the relatively direct biological influence of abnormal work hours on potential safety. These studies look at circadian variation in performance and more increasingly at sleepiness in relation to circadian rhythms (Folkard 1996b). Possible social factors affecting alertness have thus received less attention compared to biological factors. Folkard did, however, find evidence that some social factors may play an important role in determining safety levels. He quoted results from a study into mining accidents where increase in accidents on Sunday night shift was found. This was interpreted as resulting from the church going habits of the shiftworkers involved. Folkard concluded that it might only be in these somewhat atypical situations that social factors might outweigh biological ones.

With respect to the distinction between social and biological factors, these findings are comparable to the results reported in the previous chapter: it appears that social factors are more likely to be considered when biological factors fail to provide adequate explanations. Still, it seems important to pay attention to both factors. Whether or not one is more important than the other may be less relevant than considering how one factor may exacerbate the effect of the other in reducing alertness. Or how they may be able to counterbalance the effect of the other, e.g. where social factors, such as social interaction, may help to reduce the impact of increased sleepiness caused by biological factors.

Functionality of reduced alertness

The general focus in research is on reduced alertness as a problem: reduced alertness negatively affects performance and as such negatively influences safety and productivity at work. By pointing to the regulating function of increased fatigue or sleepiness due to disturbed sleep, Folkard (1996b) also considered a more positive point of view. He compared increased fatigue with increased anxiety: "Thus, for example, increased fatigue due to disturbed sleep may, as well as having an adverse effect during a shift, also increase the ease with which the shiftworker can subsequently fall asleep. In contrast, an acute increase in anxiety may have a detrimental effect on both on-shift safety and efficiency and on the subsequent sleep, and hence magnify the disturbance of biological rhythms."

5.3. On-shift alertness

Irregular work hours are associated with increased subjective, behavioural and physiological sleepiness (Åkerstedt 1991). Reduced alertness at work can be both a safety and a financial risk. Phillips et al. (1991) mentioned reduced productivity as one of the many effects of unusual work schedules and sleep deprivation of workers. Shiftworkers are regularly confronted with sleep loss, which is likely to influence their alertness. In addition, having to work at times when alertness is normally low needs also be considered.

The reduced alertness in shiftworkers is explained by the combined effect of circadian and sleep loss influences. Several questionnaire studies have shown reduced wakefulness or alertness in shiftworkers as compared to day workers (Åkerstedt 1991, Tepas & Carvalhais 1990, Tepas et al. 1993). That shiftworkers report fatigue is a fundamental observation, found in most shiftwork studies.

5.3.1. Different shifts

Differences in the sleepiness pattern have been found for the three shifts. On the afternoon shift, sleepiness is never high. The timing of this shift is at a convenient circadian time of day and allows for relatively long sleep duration and good quality sleep. The morning shift is associated with difficulties with earlier bedtimes and with subsequent early arising (Folkard & Barton 1993). As a result, this shift is also characterised by sleepiness and reduced alertness (Åkerstedt 1990). The most clearly affected shift is the night shift, where actual falling asleep on shift has been reported. Night work is associated with decreased performance through a sleep deficit caused by reduced daytime sleep duration and quality which is less restorative. Sleepiness increased during the night with a pronounced peak during the second half of the night shift, in the early morning, when the circadian rhythms are at their lowest ebb. Reduced alertness during the night shift is thus not only a result of reduced sleep quality and quantity but also of circadian rhythm disruption (Rosa et al. 1990, Tepas & Carvalhais 1990). The extent to which sleepiness is experienced during a night shift is high. Åkerstedt (1991) reported that approximately 75% of the total population on every night shift report sleepiness. In as many as 20% of these cases the sleepiness was severe enough to cause the individual to fall asleep.

5.3.2. Accumulation and adjustment

The reduced sleep duration of shiftworkers may often result in a cumulative sleep debt accruing over successive night shifts. Several authors have studied the sleep and performance of shiftworkers and have shown both to be impaired on the night shift. Deterioration in performance over successive night shifts has also been reported. This was interpreted as reflecting a build up of partial sleep deprivation. Any cumulative sleep debt that occurs is also likely to exacerbate the fact that, unless their circadian rhythms are completely adjusted, shiftworkers are far more likely to fall asleep on the job during the night shift than during the morning or afternoon shift. Thus the natural tendency to fall asleep may well be exaggerated if the shiftworker is already suffering from a relative lack of sleep (Folkard 1996b).

As was mentioned before, alertness ratings have been viewed as exponents of circadian adjustment of the shiftworker. They have been used as an indication of how well adjusted the shiftworker is to the shift worked. Several authors have looked at adjustment over longer periods of time. Rosa (1991) conducted a longitudinal study comparing 12 hour versus 8-hour shifts. He did not observe decrements in performance or alertness across the workweek, which according to the author suggested the possibility of day-to-day recovery from the extended workshift. Overall however, little improvement or adaptation over 3.5 years was apparent in any of the questionnaire measures.

Carskadon and Roth (1991) found that short-term reduction of sleep led to impaired performance and alertness. They felt that long-term effects required further study. Additional evidence that such sleep reductions led to insufficient sleep came from the finding that impairments worsen progressively over consecutive nights with equal amounts of sleep restriction (which is somewhat contrary to the Rosa's results). Finally, they found that moderate amounts of sleep extension normalised performance and alertness.

5.3.3. Napping

Severe sleepiness during the night shift is known to lead to unauthorised naps. In some countries sleepiness is evidenced in officially sanctioned night shift naps, with Japan as a prominent example (Åkerstedt 1991). Looking at naps in more detail, it was found that involuntary naps were always preceded by a struggle to stay awake, implying that the person is usually aware of what is happening. However, both the estimated length of the nap and the number of times dozing off were grossly underestimated (Åkerstedt 1991). Naitoh (1981, 1976) found that napping could lead to an increase in performance, depending on the duration of the nap, the time of day and the number of hours of sleep loss preceding the nap.

Bonnet (1990) found that performance on 'graveyard' shifts can be maintained close to baseline levels following true prophylactic nap while performance may decline by up to 30% when such naps are not taken. While there is evidence that naps or even rest periods without sleep are beneficial in improving mood in normal young adults, these data do not apply to 'replacement' naps. Studies of interjected naps imply that such naps do reduce sleep debt but do not imply that such naps are more beneficial than longer sleep periods. Naps appear to be most advantageous when the accumulated sleep debt is least.

Smith and Wilson (1990) studied the effect of naps during night duty on the mood of female nurses. The results from this study corroborated the assumption that taking a nap in the middle of the night may be of some benefit in removing mood changes and performance impairment observed towards the end of the night shift. However, the short-term problems with napping must also be recognised and if napping is allowed appropriate measures should be taken to control for waking up related problems.

5.4. Alertness, age, gender, and gender roles

Alertness, as a circadian rhythm, is likely to be affected by individual differences. Kerkhof for example reported different subjective alertness ratings for morning and evening types (Kerkhof 1985, fig 31.1C). The individual differences considered in this study (age, gender, and gender role) have received limited attention in the literature. Åkerstedt (1991) conceded that among individual differences, one might expect age to have a negative influence on sleepiness or alertness. However, he argued that this was not necessarily always the case, even though reports of sleep disturbances often increased with increasing age and experience (Foret et al. 1981, Åkerstedt & Torsvall 1981). Åkerstedt reported finding trends in EEG studies towards more superficial sleep in middle aged shiftworkers. Still, he concluded that no clear relation between age and sleepiness has been found. Nor for that matter was there one between experience and sleepiness: several authors found no effect of experience on alertness ratings even though increased health complaints were associated with more experience (Åkerstedt 1991).

Even less seemed to be known about possible effects of gender or gender role related sleep reduction on alertness. Studies reporting alertness ratings of samples of female shiftworkers do not always consider possible social and domestic factors in explaining their results. Nor do they compare men and women (e.g. Härmä 1992 a/b).

Fortunately, one exception to the general absence of age and gender related aspects in alertness research was found in the work of Monk and colleagues. In both chapters on sleep and age and on shiftwork and gender, the work of this group of researchers in relation to age and circadian rhythms has already been mentioned (e.g. Monk et al. 1995). To briefly summarise: their main findings, relevant to this study, were (i) that they did not find convincing evidence for an amplitude reduction with advancing age and (ii) that there may be a gender difference. Older women did have significantly higher amplitudes than older men and better objective sleep quality (Reynolds et al. 1991b). In terms of temperature rhythm (as an indicator of their circadian rhythms in general), older women compared better to younger men than to older men. In addition, it was found that younger women generally have a lower temperature, which was the main reason to exclude them as a comparison group in another study (Monk et al. 1995).

One of their recent papers builds on from here and not only examined alertness in relation to age, but also took gender differences into consideration (Monk et al. 1996). The results of these studies are interesting and may challenge some of the assumptions made in circadian rhythm research, especially in relation to age and gender differences. They may well add a new perspective to the issue of gender differences in relation to circadian rhythms and could provide a framework for some of the results found in this study. Therefore, even though the studies and results described, stretch well beyond the context of this thesis, the paper will be discussed in some detail.

The aim of the study was to evaluate age-related changes in the circadian rhythm of subjective alertness and to explore the circadian mechanisms underlying such changes. For the elderly it had been observed that there is often less of a difference between night and day in how alert they feel, paralleling the greater tendency towards polyphasic sleep with advancing age that has been observed in lower animals. In this study, a sample of older men and women was asked to rate their alertness over time. A comparison was made with middle aged men. The study comprised two experiments designed to test two hypotheses. First that advancing age leads to a breakdown in the circadian rhythmicity in subjective alertness. And second that this breakdown is mediated by an age-related inability of the circadian signal to be successfully transduced from the endogenous circadian pacemaker. That is: with advancing age it is not necessarily the signal itself that becomes weaker, but more the transduction of the signal.

With regard to age (hypothesis 1), the results showed that the subjective alertness rhythms of the elderly were less robust, i.e. weaker, than those of the young, even for those for whom the body temperature rhythm was intact. Advancing age resulted in less rhythmic alertness patterns, as indicated by lower amplitudes and less reliability of fitted 24-h sinusoids. This appeared in spite of the absence of any reliable age-related diminuition in circadian temperature rhythm amplitude.

These results, however, applied more to older men than to older women. The older men appeared to fare worst, showing the lowest amplitude and most phase-advanced alertness rhythms. Although older women were more likely than older men to experience subjective stress from poor sleep, the objective sleep and circadian rhythm findings all point to a male inferiority. Thus men exhibited less preservation of sleep continuity and slow wave sleep into advancing age than did women, as well as shorter REM latencies. Monk et al. add that older women have also been found to have higher temperature rhythm amplitudes than older men (Czeisler et al. 1992, in Monk 1996), with unmasked temperature rhythms of older women closer in amplitude to those of young men than those of older men. Plus there is evidence that older women respond better to a phase shift. With this added to the results from the alertness study, Monk et al. subsequently conclude that clearly the sleep and circadian systems of men and women do not age equally well.

The results, according to the authors, suggested that the effect was not due to SCN (suprachiasmatic nuclei, 'the endogenous circadian body clock') weakness per se, but to weakened transduction, which is in line with hypothesis 2. This was tested with a further experiment which indeed showed difference in amplitude of the alertness rhythm suggesting that with advancing age (particularly in men) there is less rhythmic input into subjective alertness from the endogenous circadian pacemaker.

The results were explained in terms of a diminished influence of the ECP (endogenous circadian pacemaker, or body clock) as the determinant of subjective alertness, even in those elderly people for whom body temperature rhythms are still quite robust.

According to the authors, these results may explain some of the nocturnal insomnia and daytime hypersomnia that afflict many elderly people, because a robust circadian alertness rhythm would be associated with sleepiness at night and alertness during the day.

Monk et al. next link their results to the circadian alertness model developed by Folkard and Åkerstedt (1992). This model, as described above, assumes that alertness ratings result from three factors: a sleep inertia factor (S), a time since wakening factor (W) and an ECP factor (C), normally indicated by the body temperature. The diminished influence of the ECP is considered in relation to the increased tendency towards morningness found in older people. Should the influence of C on subjective alertness be diminished in advanced age, even in those elderly for whom C is still quite strong (as evidenced by body temperature), then the comparatively unbridled influence of S (which simply increases subjective sleepiness as the day progresses) might explain not only daytime napping propensity but also the tendency of seniors to be more morning types in their circadian disposition. This might explain why older people rate higher on scores of morningness, going to bed earlier than their younger counterparts. This is in line with the conception of the ECP as a force for consolidating wakefulness as well as for preparing for sleep. Without the increase of alertness in the evening by C, a 2200 or 2300 h bedtime may be difficult to obtain. The decreasing tendency in alertness observed in the older subjects bears witness of the fact that the influence of S is still quite strong in this group (Monk et al. 1996).

However, one issue can be raised in reaction to the assumption that the observed lower alertness rating was connected to increased morningness. After all, the weaker alertness rhythm was more specifically found for older men compared to older women. In the literature (Kerkhof 1985, Moe et al. 1991, Wever 1985) is it generally assumed that women are more likely to be morning types than men, next to a general increase of morningness with age for both sexes. Although not necessarily in contradiction with Monk's line of reasoning, this does also not neatly fit in with his reasoning because women were found to be less affected by the weaker ECP signal and would thus be less likely to be morning types. So the question raised is how this result related to the finding that women are assumed to be more morning types compared to men. Would this mean that women are less affected by an increase in morningness with advanced age because they are already more likely to be morning types? Or does this finding simply not fit in with the reasoning followed by Monk et al. (1996)?

5.5. Literature summary

Reduced alertness is a prominent and acute effect of sleep loss. Alertness has a distinct 24-hour rhythm and is one of the few psychological circadian variables. The development of a model for predicting alertness confirmed the importance of alertness as a psychological circadian rhythm. In addition, alertness is clearly linked to performance and safety at work. Finally, alertness as been used as a measure of adjustment of circadian rhythm (e.g. in the case of shiftwork) and it may be a predictor of an individual's phase.

With regard to the situation of shiftworkers, there is sufficient evidence in the literature that shiftworkers experience reduced alertness as a result of their sleep deficit. It has been argued that this increased on-shift sleepiness may have negative consequences for safety and productivity at work. This warrants attention to the effects of sleep loss on the alertness of the persons involved in this study.

The night shift is the most clearly affected shift, due to the combined effect of sleep deprivation and circadian rhythm disruption. There is a well-established performance decrement around 04:00. The morning shift is also affected because of the early rise times and the problems with earlier bedtimes. As a result alertness may be most reduced during the first few hours of this shift. Although the afternoon shift is not likely to be affected by reduced alertness due to lack of sleep, there is a reported second performance decrement around 14:00/16:00 hours, which is at the start of the afternoon shift.

In explaining reduced alertness, the emphasis seemed to be more on sleep duration reduction per se than on sleep duration combined with a reduction in sleep quality.

Despite the confirmed relation between reduced sleep and older age, no ensuing link with sleepiness in relation to age has been established. In fact a gender difference may have been found. Monk et al. (1996) concluded that the sleep and circadian rhythms of men and women do not age equally well. In their studies, women seemed to fare better. In addition, the affected sleep of female shiftworkers with high domestic commitment has not been known to result in reduced alertness at work. In general, in the discussion of affected alertness at work, biological factors have received more attention than social factors.

5.6 Analysis

In the follow-up questionnaire, nurses were asked to rate their alertness retrospectively. They were instructed to use the rating scales to indicate how alert or sleepy they normally felt at 2-hourly intervals before, during and after the different shifts they worked. In the case of the night shift, they were asked to consider only a second or subsequent night shift and not the first night in order to avoid differences as a result of a longer period of wakefulness prior to this shift. A nine-point rating scale was used with scores ranging from very alert (1) to very sleepy (fighting sleep, 9). For the purpose of the analyses the scores were reversed.

Elsewhere it has been shown that these retrospective ratings compare very well to concurrent alertness ratings. Retrospective measures of alertness were shown to be sensitive to both time of day and shift, and had high level of reliability even for relatively small sample sizes (e.g. 10) and to be valid predictors of more traditional concurrent measures of alertness (Folkard et al. 1995).

Because of the limited impact of gender as a variable and the unequal group sizes, male shiftworkers will no longer be considered in the analyses. And permanent night nurses and rotating shift nurses will from now on be considered separately because of the substantial differences between the two groups, reported in the previous chapter. Because alertness ratings were only given by nurses who completed the follow-up questionnaire, analyses are restricted to the follow-up sample (N=648 versus 1532 for the SSI, see appendix II).

5.6.1 Two-hourly alertness ratings

Figures 5.1a and 5.1b show alertness ratings for the different shifts. Permanent night nurses have a higher overall alertness rating for the night shift compared to rotating shift nurses. Analysis of variance for repeated measures showed a significant main effect (F=91.67(327,1), p<.001) and a significant interaction effect (F=2.14(2289,7), p<. 05).

Figure 5.1a: Alertness ratings for the **night shift** for permanent night nurses (pn nurs) and rotating nurses (rota nurs).

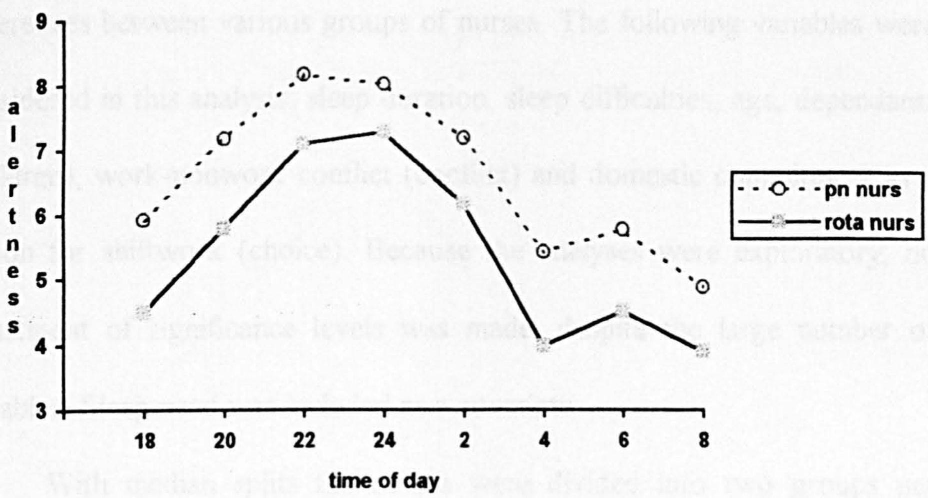
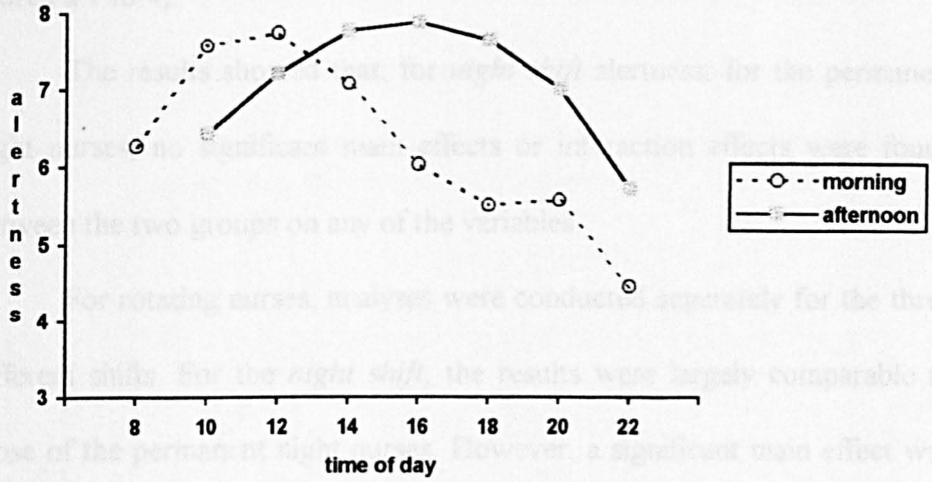


Figure 5.1b: Alertness ratings for the **morning and afternoon shift** for rotating nurses.



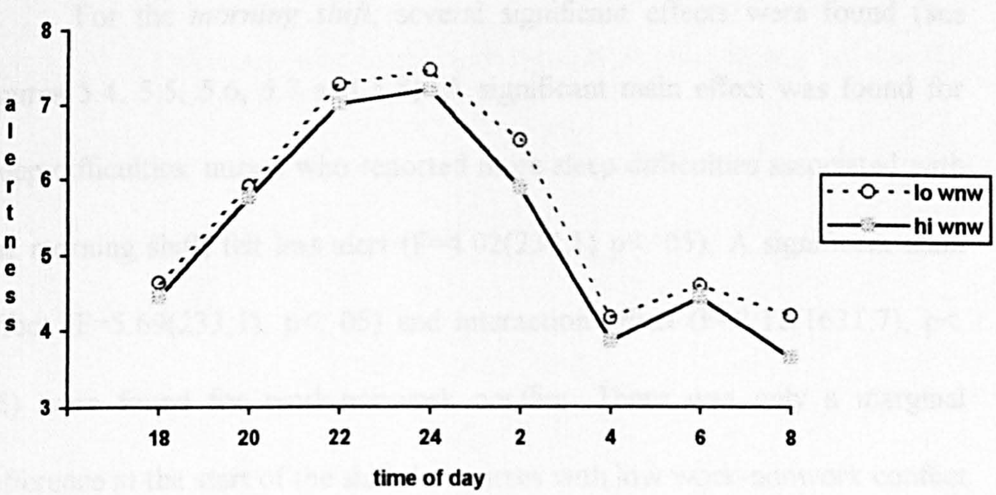
Further analysis considered both groups of nurses separately and looked at the variables considered in the previous chapters. Repeated measures analysis of variance was conducted to investigate possible differences between various groups of nurses. The following variables were considered in this analysis: sleep duration, sleep difficulties, age, dependants (children), work-nonwork conflict (conflict) and domestic commitment as a reason for shiftwork (choice). Because the analyses were exploratory, no adjustment of significance levels was made, despite the large number of variables. Sleep need was included as a covariate.

With median splits the nurses were divided into two groups per variable, e.g.: high and low problem scores, older and younger nurses. For two variables, a median split was not used and the groups were split unevenly. The majority of permanent night nurses had dependants at home (N=140 yes, N=60 no) and had chosen night work because it fitted in with their domestic commitment (N=153 scored a 5, N=48 scored a 1 to 4). For the rotating nurses, this situation was reversed (N=196 without dependants and N=46 with dependants, N=62 scored a 5 for domestic reasons, N=185 scored a 1 to 4).

The results showed that, for *night shift* alertness, for the permanent night nurses, no significant main effects or interaction effects were found between the two groups on any of the variables.

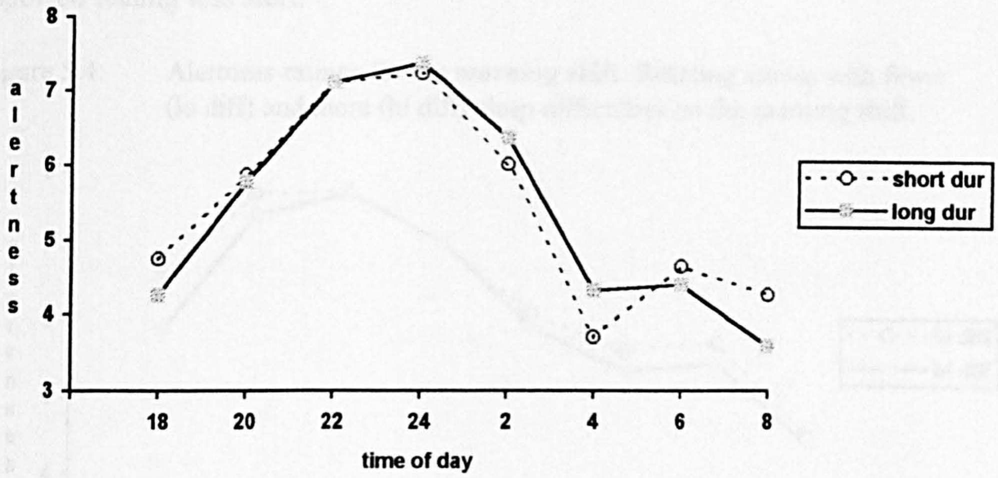
For rotating nurses, analyses were conducted separately for the three different shifts. For the *night shift*, the results were largely comparable to those of the permanent night nurses. However, a significant main effect was found for low and higher levels of work-nonwork conflict ($F=7.06(180,1)$, $p<.05$). Nurses with low work-nonwork conflict rated their alertness as higher compared to high work-nonwork conflict scorers, as can be seen in figure 5.2.

Figure 5.2: Alertness rating for the **night shift**. Rotating nurses with low (lo WNW) and high (hi WNW) levels of work-nonwork conflict.



A significant interaction effect was found for the variable sleep duration on the night shift ($F=3.42(1260,7)$, $p<.001$). As can be seen from figure 5.3, rotating nurses with a shorter sleep duration on the night shift had a much more pronounced dip in alertness at 04:00 and lower alertness ratings for most of the on-shift ratings. Towards the end of the shift, they felt, however, more alert compared to nurses who had slept longer.

Figure 5.3: Alertness rating for the **night shift**. Rotating nurses with shorter and longer sleep duration on the night shift.



For the *morning shift*, several significant effects were found (see figures 5.4, 5.5, 5.6, 5.7 and 5.8). A significant main effect was found for sleep difficulties: nurses who reported more sleep difficulties associated with the morning shift, felt less alert ($F=4.02(234,1)$ $p<.05$). A significant main effect ($F=5.69(233,1)$, $p<.05$) and interaction effect ($F=2.12(1631,7)$, $p<.05$) were found for work-nonwork conflict. There was only a marginal difference at the start of the shift, but nurses with low work-nonwork conflict scores felt more alert towards the end of the shift and during the afternoon and evening. A significant interaction effect ($F=3.10(1484,7)$, $p<.01$) was found for sleep duration: nurses with a shorter sleep duration on the morning shift, felt less alert at the start of the shift, but more alert in the evening. Another significant interaction effect was found for age ($F=2.98(1624,7)$, $p<$.

05). Younger nurses felt less alert during work hours, but these differences disappeared in the early evening. Finally, a significant interaction effect (F=2.82(1470,7), p<. 05) was found for rotating nurses with and without dependants at home. For most of the ratings, nurses without dependants reported feeling less alert.

Figure 5.4: Alertness ratings for the **morning shift**. Rotating nurses with fewer (lo diff) and more (hi diff) sleep difficulties on the morning shift.

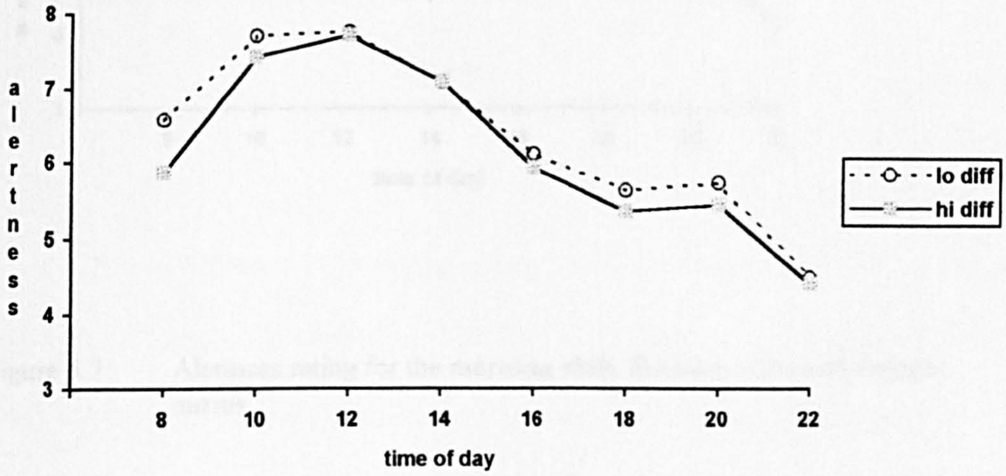


Figure 5.5: Alertness rating for the **morning shift**. Rotating nurses with low and high work-nonwork conflict.

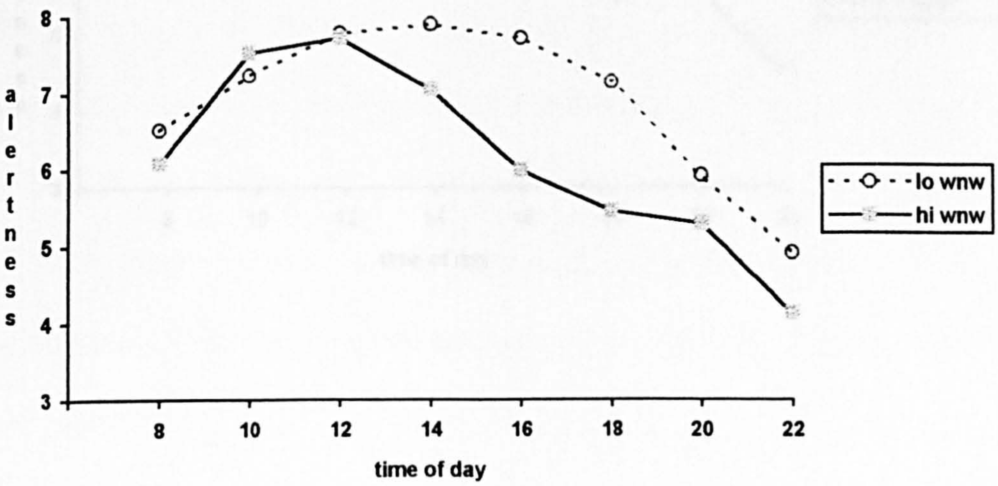


Figure 5.6: Alertness rating for the **morning shift**. Rotating nurses with shorter and longer sleep duration on the morning shift.

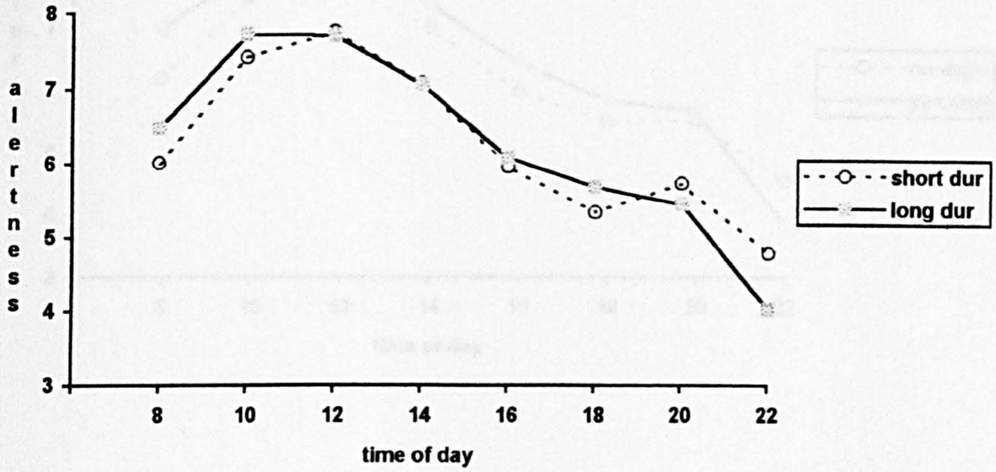


Figure 5.7: Alertness rating for the **morning shift**. Rotating older and younger nurses.

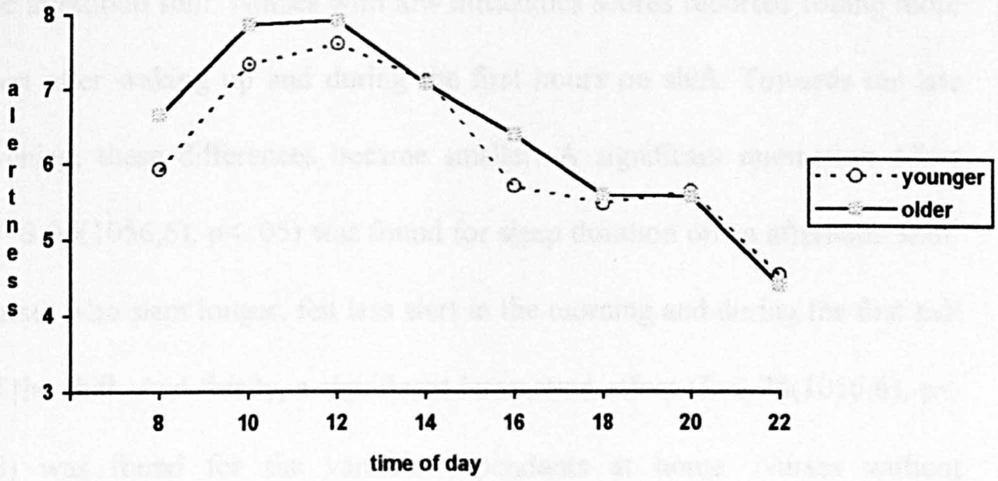
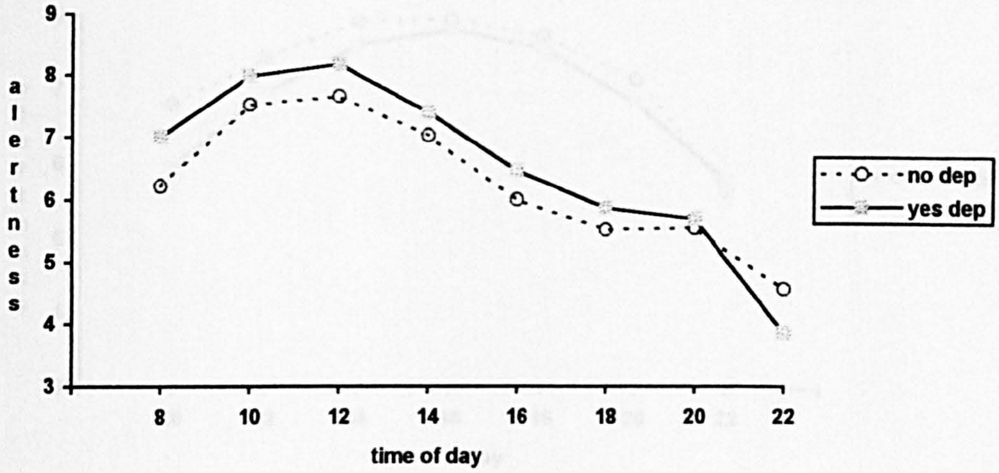


Figure 5.8: Alertness ratings for the **morning shift**. Rotating nurses without and with dependants at home.



For the *afternoon shift*, the results can be seen in figures 5.9, 5.10 and 5.11. A significant main ($F=6.13(192,1)$, $p<.05$) and interaction effect ($F=4.50(1152,6)$, $p<.001$) were found for sleep difficulties associated with the afternoon shift. Nurses with low difficulties scores reported feeling more alert after waking up and during the first hours on shift. Towards the late evening, these differences became smaller. A significant interaction effect ($F=3.06(1056,6)$, $p<.05$) was found for sleep duration on an afternoon shift: nurses who slept longer, felt less alert in the morning and during the first half of the shift. And finally, a significant interaction effect ($F=2.78(1056,6)$, $p<.05$) was found for the variable dependants at home. Nurses without dependants felt less alert in the morning and at the start of the shift, but more alert in the evening.

Figure 5.9: Alertness rating for the **afternoon shift**. Rotating nurses with fewer and more sleep difficulties on the afternoon shift.

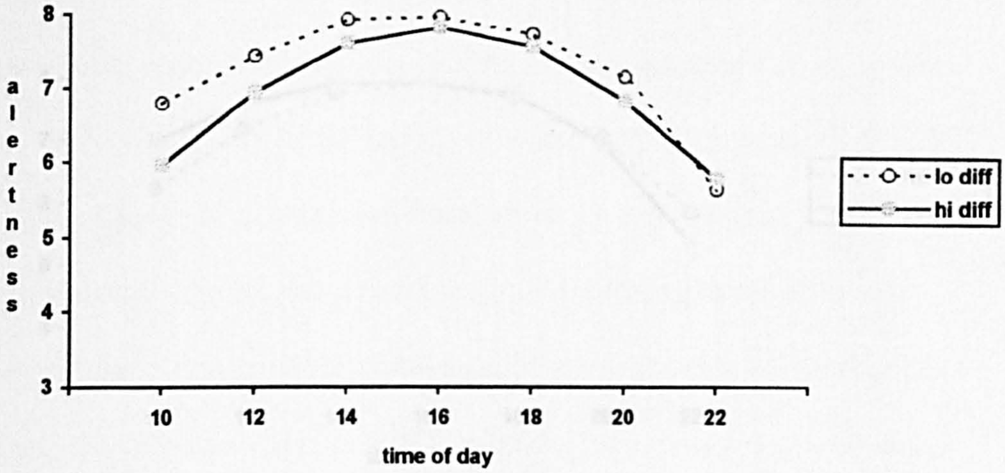


Figure 5.10: Alertness ratings for the **afternoon shift**. Rotating nurses with shorter and longer sleep duration on the afternoon shift.

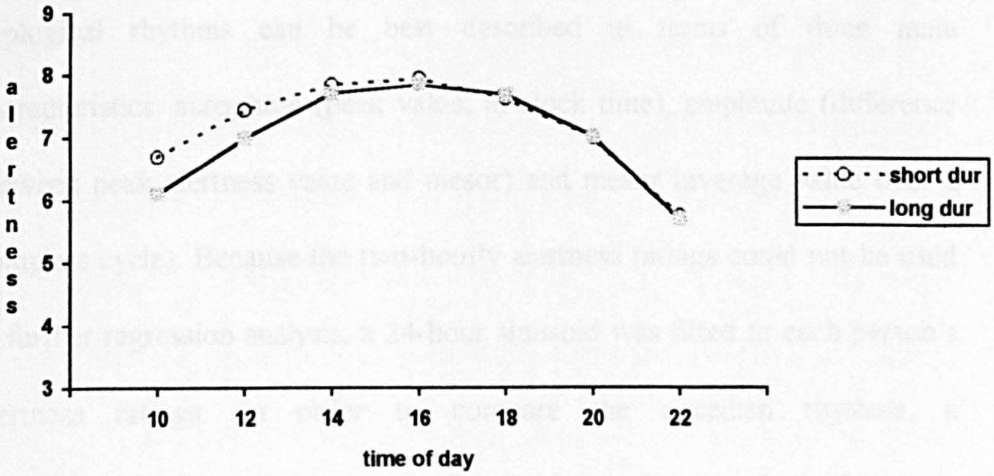
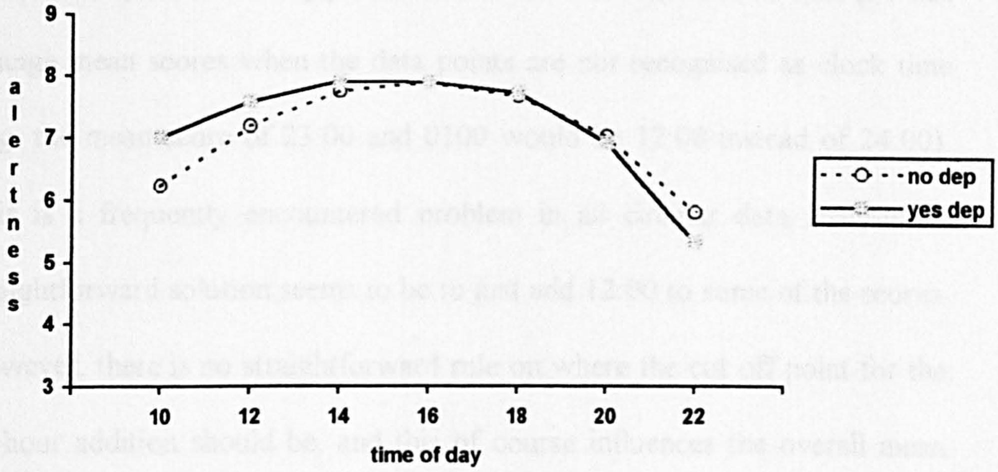


Figure 5.11: Alertness ratings for the **afternoon shift**. Rotating nurses without and with dependants at home.



5.6.2 *Acrophase, amplitude, and mesor*

Biological rhythms can be best described in terms of three main characteristics: acrophase (peak value, in clock time), amplitude (difference between peak alertness value and mesor) and mesor (average value over a complete cycle). Because the two-hourly alertness ratings could not be used in further regression analysis, a 24-hour sinusoid was fitted to each person's alertness ratings. In order to compare the circadian rhythms, a mathematically fitted sine curve is often used to estimate a rhythm's mesor, acrophase and amplitude. The analysis here was conducted with the aid of the programme ChronoLab 3.0 (Mojón et al. 1992), which resulted in estimates of the acrophase (clock time of fitted peak), amplitude (fitted peak level minus mean level) and mesor (mean level of fitted curve, i.e. average level of variable) for subjective alertness. Individual scores were included if the number of scores was > 3 and if the minimum score was not equal to the maximum score (i.e. not all scores were identical). A single fit was used. This is a fit based on a 24-hour cosinor. With regard to the acrophase data (giving a clock time) the following problem was encountered. Circular data provide strange mean scores when the data points are not recognised as clock time (e.g. the mean score of 23:00 and 0100 would be 12:00 instead of 24:00). This is a frequently encountered problem in all circular data analysis. A straightforward solution seems to be to just add 12:00 to some of the scores. However, there is no straightforward rule on where the cut off point for the 12-hour addition should be, and this of course influences the overall mean score. The cut off depends on whether one would consider some scores to be a late or an early peak. In order to ensure meaningful mean scores the following procedure was followed. The mode was used as a cut off point. Twelve hours was either added to or substracted from the mode. A new mean was calculated and all scores more than three standard deviations away from the mean were discarded. For the rotating nurses 3 scores for the morning shift, 9 for the afternoon shift, and 4 for the night shift were discarded. For the permanent night nurses, 3 scores for the night shift were discarded. This procedure is a commonly used method for this frequently encountered problem for which there is no standard way to resolve this (Folkard, van Someren, personal communication). The resulting average scores for the acrophase, together with the average scores for the mesor and amplitude are given in table 5.1. The above method evidently affected the mean scores for the night shift (mode 13:00 for the permanent night shift and 12:00 for the rotating night shift). It did not change the mean scores of the acrophase on the afternoon shift (mode 02:00), so there the original scores could be used. For the morning shift scores (mode 01:00), only three data points needed to be recoded. The results (see table 5.1.) showed that the acrophase (i.e. time of fitted peak) was very different for the three shifts worked. The acrophase for the rotating shift nurses was later in time compared to the peak of the permanent night nurses. The amplitude was lowest for the morning shift. The mesor was lowest for rotating nurses on a night shift and highest for the morning shift. These results are in line with the reported graphs in figures 5.1a and 5.1b. The mesor, acrophase and amplitude values on the night shift were tested for significance between the permanent night nurses and the rotating shift nurses. T-tests showed only the mesor to be significantly different between the two groups. The results indicate a higher overall alertness level for the permanent night nurses.

Table 5.1:
Acrophase, amplitude and mesor for the different shifts.

Variable mean (s.d).	Acrophase	Amplitude	Mesor
Permanent night nurses: night shift	22.94 (3.03)	2.75 (1.48)	5.48*(1.56)
Rotating shift nurses: night shift	23.19 (3.00)	2.74 (1.31)	4.40*(1.35)
afternoon shift	15.81 (2.26)	3.07 (1.75)	5.45 (1.59)
morning shift	11.07 (3.57)	2.08 (0.98)	5.92 (1.18)

*significant difference: $t=7.72$, $p< 0.001$

Subsequently, the three variables were used in regression analyses to look at the relative impact of the various variables on alertness, controlling for sleep need. The results of the analysis can be found in table 5.2 through 5.5. The influence of the variables distinguished in this study appeared to be limited. Only a few significant results were found. The analyses showed that the acrophase of the permanent night nurses was not influenced by any of these variables. Sleep duration on the night shift seemed to affect both the amplitude and the mesor of the reported alertness rhythm, with the mesor also being influenced by the reported sleep difficulties associated with the night shift. Longer sleep duration on the night shift was related to lower amplitude. A negative relation was found for the mesor, indicating that a higher mesor was related both to shorter night shift related sleep duration and to less reported sleep difficulties associated with the night shift. For the rotating nurses, the results for the night shift were comparable to the permanent night nurses. However, the influence of sleep difficulties associated with the night shift was not established. For the morning shift, only the mesor was influenced by age and work-nonwork conflict. Older age and less work-nonwork conflict were related to a higher mesor. For the afternoon shift, both the amplitude and the mesor were influenced by sleep duration on the afternoon shift, only in opposite directions: longer sleep duration was related to a higher amplitude and a lower mesor. The acrophase was influenced by sleep difficulties associated with the afternoon shift: more sleep difficulties were related to a later acrophase. Although the results are minimal, looking across the three alertness dimensions, the results show that the sleep variables, and most notably sleep duration, were the only main sources of influence on the alertness dimensions. Amplitude and mesor levels were mainly influenced by sleep duration related to the different shifts, with the exception of the morning shift, where age and work-nonwork conflict were more important. Sleep difficulties influenced the alertness dimensions to a lesser extent.

Table 5.2:
Permanent night nurses/night shift
Regression analysis of age, sleep and
gender roles on alertness variables: beta weights

Variable	Acrophase	Amplitude	Mesor
Age	n.s.	n.s.	n.s.
Work-nonwork conflict	n.s.	n.s.	n.s.
Sleep duration	n.s.	.289**	-.240**
Dependants	n.s.	n.s.	n.s.
Sleep difficulties	n.s.	n.s.	-.199*
Domestic reason for shiftwork	n.s.	n.s.	n.s.
R^2	----	.129	.149

significant difference: * $p <= 0.05$ ** $p <= 0.01$ *** $p<= 0.001$ n.s.: not significant

Table 5.3:
Rotating nurses/night shift
Regression analysis of age, sleep and
gender roles on alertness variables: beta weights

Variable	Acrophase	Amplitude	Mesor
Age	n.s.	n.s.	n.s.
Work-nonwork conflict	n.s.	n.s.	n.s.
Sleep duration	n.s.	.284**	-.293***
Dependants	n.s.	n.s.	n.s.
Sleep difficulties	n.s.	n.s.	n.s.
Domestic reason for shiftwork	n.s.	n.s.	n.s.
R^2	----	.088	.150

significant difference: * $p <= 0.05$ ** $p <= 0.01$ *** $p<= 0.001$ n.s.: not significant

Table 5.4:
Rotating nurses/morning shift
Regression analysis of age, sleep and
gender roles on alertness variables: beta weights

Variable	Acrophase	Amplitude	Mesor
Age	n.s.	n.s.	.151*
Work-nonwork conflict	n.s.	n.s.	-.232**
Sleep duration	n.s.	n.s.	n.s.
Dependants	n.s.	n.s.	n.s.
Sleep difficulties	n.s.	n.s.	n.s.
Domestic reason for shiftwork	n.s.	n.s.	n.s.
R^2	----	----	.126

significant difference: * $p <= 0.05$ ** $p <= 0.01$ *** $p<= 0.001$ n.s.: not significant

Table 5.5:
Rotating nurses/afternoon shift
Regression analysis of age, sleep and
gender roles on alertness variables: beta weights

Variable	Acrophase	Amplitude	Mesor
Age	n.s.	n.s.	n.s.
Work-nonwork conflict	n.s.	n.s.	n.s.
Sleep duration	n.s.	.187*	-.272***
Dependants	n.s.	n.s.	n.s.
Sleep difficulties	.164*	n.s.	n.s.
Domestic reason for shiftwork	n.s.	n.s.	n.s.
R^2	.098	.080	.143

significant difference: * p <= 0.05 ** p <= 0.01 *** p<= 0.001 n.s.: not significant

5.7. Discussion

In this chapter, the effect on alertness of the relationship between age and sleep was investigated. Reduced alertness is a prominent and acute effect of sleep loss. Alertness has a distinct 24-hour rhythm and is the most important psychological circadian rhythm. The development of a model for predicting alertness confirmed the importance of alertness as a psychological circadian rhythm. Alertness has been linked to performance and safety at work, used as a measure of adjustment of circadian rhythm (e.g. in the case of shiftwork), and it may be a predictor of an individual's phase. There is sufficient evidence that shiftworkers experience reduced alertness as a result of their sleep deficit. Again, this increased on-shift sleepiness may have negative consequences for safety and productivity at work. This warrants attention to the effects of sleep loss on the alertness of the persons involved in this study. In shiftwork, the night shift is the most clearly affected shift, due to the combined effect of sleep deprivation and circadian rhythm disruption. There is a well-established performance decrement around 04:00. The early rise time and problems with early bedtimes affect alertness on the morning shift. Reduced alertness is less likely to be a problem during the afternoon shift. In explaining reduced alertness, the emphasis seemed to be more on sleep duration reduction per se than on sleep duration combined with a reduction in sleep quality.

Despite the confirmed relation between reduced sleep and older age, no ensuing link with sleepiness in relation to age has been established. In fact a gender difference may have been found. Monk et al. (1996) concluded that the sleep and circadian rhythms of men and women do not age equally well. In their studies, women seemed to fare better. Although no gender differences were directly tested in this study, the results do seem to be in line with the results by Monk et al (1996). In addition, the affected sleep of female shiftworkers with high domestic commitment has not been known to result in reduced alertness at work. In general, in the discussion of affected alertness at work, biological factors have received more attention than social factors and most research has used male workers resulting in little gender-oriented work.

In this study, alertness scores were considered separately for the permanent night nurses and the rotating shift nurses. Overall, the permanent night nurses rated their alertness significantly higher for the night shift, compared to nurses working rotating shifts. Possible alertness differences related to a number of variables were considered next. The variables considered were sleep duration and sleep difficulties, age, dependant, work-nonwork conflict, and domestic commitment as a reason for choosing shiftwork. The nurses were split into two groups of either high or low scores on the variables considered. For the permanent night nurses, no significant differences were found for any of the variables considered. On the basis of their sociodemographic information, presented in the previous chapter and in appendix II, this could be explained in terms of the group being very homogenous. The permanent night nurses were older, compared to rotating shift nurses, were more likely to have children and to have chosen night work because it fitted in with their domestic commitment.

For the rotating shift nurses, more significant differences were found. With regard to sleep, for the *night shift*, a pronounced dip in early morning alertness was found for nurses with a shorter sleep duration on the night shift (below 7 hours) compared to nurses who slept longer. For the *morning shift* a main effect was found for sleep difficulties associated with the morning shift: a higher level of reported sleep difficulties was associated with reduced on-shift alertness. For sleep duration an interaction effect was found: nurses with shorter sleep duration on the morning shift (below 7,25 hours) felt less alert at the start of the shift, but more alert towards the end. For the *afternoon shift*, a main and an interaction effect were found for sleep difficulties associated with this shift: nurses with a low sleep difficulties score reported feeling more alert after waking up and during the first hours on shift. For sleep duration on the afternoon shift, again an interaction effect was found: nurses who slept longer (over 9.5 hours!) felt less alert in the morning and during the first half of the shift.

In all, these result largely support the assumed relation between alertness and reduced sleep. Interestingly, next to sleep duration, reported sleep difficulties seemed to have an equally strong relationship to reported alertness. For both the morning and even the afternoon shift a main effect of sleep difficulties was found. The finding for the night shift result was as could have been expected: less sleep may make the night shift dip more pronounced, maybe as a result of limited circadian adjustment, reflected in the shorter sleep duration. The sleep duration effects for the morning and afternoon shift were reversed: shorter sleep duration on the morning shift and longer sleep duration on the afternoon shift were associated with reduced alertness during the first few hours on shift. The finding for the afternoon shift seems in line with the results Anderson and Bremer (1987) reported. Overall, the results underlined the relevance of reduced sleep duration on reduced subsequent alertness. In addition, some evidence for an impact of reported sleep difficulties on reduced alertness was also established.

The influence of age and gender roles on alertness ratings of the permanent night nurses was not effectively established. This is not in contradiction with previous findings. Åkerstedt (1991) already commented on the absence of a link between sleepiness and age. In fact in this study, the highest alertness ratings were also reported by permanent night nurses who were on average older.

For the rotating shift nurses, only an interaction effect was found for age for the morning shift, with younger nurses reporting feeling less alert. This could be a reflection of the increased morningness tendency in older nurses, which would make older nurses feel more alert in the morning. Alternatively, this could be explained in terms of less adjustment of their social life to their work life of the working nurses (Folkard et al. 1978, see also below).

With regard to gender roles, various results were found for the rotating shift nurses. For work-nonwork conflict, a significant main effect was found for the night shift and a main and interaction effect for the morning shift. Both results indicated that nurses with higher work-nonwork conflict ratings reported feeling less alert. For the morning and afternoon shift, a significant interaction effect was found with the variable dependants at home. For most on-shift ratings, nurses without dependants felt less alert. Both findings could be explained in terms of limited adjustment to their work routine of the younger rotating nurses with no dependants at home. This is in line with earlier findings in the literature. Folkard et al. (1978) already explained differences in long-term adjustment in terms of differences in the degree to which the nurses scheduled their lives towards night work. In the previous chapter it was already reported that work-nonwork conflict scores were in general highest for younger nurses on rotating shiftwork with no dependants at home. These nurses were least likely to have chosen shiftwork because it fitted in with their domestic commitment. The picture presented on the basis of these results is that of the younger nurse, with no dependants, reporting higher levels of sleep difficulties and work-nonwork conflict, and reporting shorter sleep duration, all of which resulted in reduced on-shift alertness.

In addition, cosinor fits were conducted in order to include the alertness ratings in regression analysis. This resulted in three relevant variables for the alertness dimension: an estimate of the acrophase, the amplitude and the mesor. These three variables were used as dependent variables in the regression analysis. The results did confirm the relevance of sleep duration as a factor affecting on-shift alertness. Less evidence was found for the influence of sleep difficulties on these dimensions of alertness. The influence of afternoon shift sleep difficulties on the acrophase seemed remarkable since sleep difficulties on this shift are not that frequent. To some degree the influence of work-nonwork conflict and age could also be established. These results seemed to point again to the relevance of choice and commitment in relation to negative effects of shiftwork on the worker.

Alertness may also be looked at in terms of adjustment to shiftwork (Folkard 1996a). The model presented by Folkard has been used to predict trends in adjustment. The results presented here seem largely in line with the results presented by Folkard (figure 2.12, p. 54), adding to the predictive strength of the model. In this respect, the higher average alertness ratings of the permanent night nurses are also interesting. Folkard points to the relevance of the shift system under consideration. In general the rhythms in both body temperature and self-rated alertness (or sleepiness) typically showed very little adjustment to a rapidly rotating shift system and most adjustment on a permanent shift system. As such the higher average alertness rating scores of permanent night nurses on the night shift, as expressed in their higher mesor, are evidence of their better adjustment to shiftwork. Better adjustment should also be found in a later acrophase. However, the permanent night nurses in this study reported a slightly earlier acrophase on the night shift (22.94 vs. 23.19 for the rotating shift nurses). There are two possible explanations for this result. First, adjustment difference may only be shown in the mesor and not in the acrophase as a result of a restricted range of alertness readings. In this study, there were two readings before the start of the night shift and only one following the end of the night shift. The problem comes from fitting a 24 hour sine curve to less than 24 hours of data. A second explanation could be found in the influence of wake-up time on the acrophase. Recently, Folkard et al. (1999) have shown that the acrophase of the endogenous component occurs about 9-10 hours after waking-up. In this sample, the wake-up time in between two night shifts, for the permanent night nurses was indeed earlier (15.88 versus 16.08 for the rotating shift nurses). Correlations between wake-up time and acrophase for the night shift were .23 for the permanent night nurses and .18 for the rotating shift nurses ($p < 0.01$ for both groups).

The higher alertness rating of older nurses also lends support to the data reported by Monk et al. (1996), that older women seem to fare better. Although no comparison could be made between men and women, results did show that older female nurses reported higher alertness ratings compared to younger female nurses.

In all, the results confirmed the importance of sleep duration as a predictor of subsequent on-shift alertness. This could be seen as an indication of the fact that reduced alertness is an acute effect rather than a chronic effect. This is in line with the sleep-deprivation literature, which looks at short term and immediate reduction of sleep duration. Reduced sleep duration will have an immediate impact on subsequent on-shift alertness. Next, the results seemed in agreement with the predictive model for adjustment to shiftwork developed by Folkard and Åkerstedt (1992). Finally, the overall higher alertness rating of older nurses was in line with results of

Monk et al. (1996) and thus lend support to their idea that women, in circadian terms, may age differently and better, compared to men.

Following the more immediate effects of sleep deprivation, in the next chapter attention will turn to chronic effects on the health and well being of the shiftworker.

6

CHRONIC EFFECTS:

HEALTH AND WELL-BEING

6.1. Introduction

In the previous chapters, the relationship between age and sleep was discussed, followed by the influence of gender roles and shiftwork on this relationship. Age was found to have an impact on sleep and this impact was, in turn, influenced by shiftwork and by gender role aspects. Having discussed possible causes of reduced or impaired sleep, attention then turned to the main acute effect of reduced sleep: reduced alertness. Here, a moderate relationship between reduced sleep and reduced alertness could be established. According to the underlying SSI model (see chapter 1) next to acute effects, chronic effects need to be considered as the next step. In this final data-analysis chapter, attention will focus on chronic effects of reduced sleep: the impact on health and well-being.

In this chapter, health, and more specifically health complaints, refers to specific physical and mental health problems. Well-being refers to a more general state. Shiftworkers may often experience a general lowered level of well-being, which consists of a conglomerate of complaints that are not specifically related to a disorder or health complaint. A good comparison may be the effect jet-lag has, where a lowered level of well-being is reported. This consists of a number of complaints that can vary according to degree of severity, frequency of occurring, and duration. In the case of jet-lag for example: increased irritability, fatigue, digestive complaints, sleep problems, and lack of concentration. Similarly, shiftworkers will frequently suffer from (mild to more serious degrees of) sleep problems, fatigue, and digestive complaints. The health outcomes considered in this study were fatigue, general well-being, neuroticism, digestive complaints and cardiovascular complaints.

Because the sample involved shiftworkers, the emphasis is on chronic effects resulting from a more chronic sleep deprivation. Incidental sleep loss was not considered in this study. Sleep deprivation literature has shown that recovery after incidental sleep loss is quick and that there is no evidence to assume more chronic effects emanating from incidental sleep loss (Naitoh et al. 1990).

In reviewing the literature on health and well-being, the scope is limited to health and well-being problems related to shiftwork, sleep, age, and gender. In the analysis section, these variables will be related to the various health and well-being measures included in this study. Finally, it will be attempted to replicate the temporal ordering, as proposed by the SSI model, for the sample under study.

6.2. Sleep, health and well-being

Sleep disturbances and chronic sleep deprivation have been associated with poorer health (Scott & LaDou 1990). Research has shown that morbidity and even mortality, as well as well-being in general, are affected by reduced sleep quality and quantity (Kripke et al. 1979). Acute effects are irritability and lack of concentration. At a more chronic level there is a lowered level of well-being which comprises several symptoms, both physical and in relation to the nervous system (Costa 1996).

Reduced sleep quality and quantity are strongly associated with chronic or persistent fatigue. Incidental fatigue is commonly the result of a single night of sleep loss. However, more chronic sleep problems are likely to be associated with more chronic fatigue. Which in turn is associated with more serious health problems (Costa 1996). As such, chronic fatigue is seen as one of the clearest manifestations of lowered well-being, resulting from reduced sleep and sleep problems.

Sleep complaints are a major complaint of shiftworkers. But how do these sleep complaints affect the health of the worker? And is it clear that these sleep complaints result in health problems or are other factors responsible for the occurrence of health problems? And what is the moderating role of individual differences such as age, and gender roles?

6.3. Shiftwork, health and well-being

It is generally agreed that shiftwork is not beneficial for the workers' health. Health and well-being are negatively affected by working shifts. There is ample evidence to assume that shiftworkers never fully adjust to their situation. Therefore they will continue to experience problems at different levels of intensity and these problems will become chronic in nature. These problems are likely to increase with age, because experience does not counterbalance the adverse effects of working shifts (Foret et al. 1981).

There is increasing evidence of an association between prolonged exposure to the negative consequences of shiftwork and a number of specific health complaints. In describing the effects of shiftwork Colquhoun and Rutenfranz (1980) used the stress-strain concept. The objective stress resulting from the disruptions of physiological rhythms by shiftwork and from the slow rate of re-entrainment of these rhythms to the changed wake/sleep cycle, induce a state of subjective strain in the shiftworker that can potentially affect their working efficiency, their physical and psychological health and well-being and their family and social life.

Despite the general agreement, establishing negative chronic effects of shiftwork is not easy. This may explain the relatively small number of studies found, specifically addressing the health outcomes of shiftwork, compared to, for example, the literature on sleep and shiftwork. As a result, this review is largely based on three reviews of the health and well-being effects of shiftwork

(Costa 1996, Harrington 1978, Waterhouse et al. 1990). A number of confounding factors is responsible for this situation.

6.3.1. Confounding factors

Establishing links between shiftwork and health problems is not straightforward. Several factors intervene in the process and are likely to obscure associations. Most factors can have both negative and positive effects on shiftwork tolerance and the development of health complaints. They can also interact or interfere with each other, so that it is often very difficult to evaluate the actual degree of harmfulness of shiftwork in different individuals or populations (Costa 1996).

An important factor is the Healthy Worker Effect (Knuttson & Åkerstedt 1992). It is assumed that the majority of persons who cannot tolerate shiftwork, and who are most likely to develop health complaints, will leave shiftwork within the first 5 years. Thus, most studies consider a survival population, a self-selected group. Chronic complaints need time to develop, which means they are best investigated in experienced shiftworkers. However, chronic health effects will be harder to establish in these self-selected groups. In fact, several studies have found that more health complaints were found in former shiftworkers compared to shiftworkers or dayworkers (Costa 1996, Frese & Semmer 1986). In addition it has been shown that shiftworkers may underestimate their problems when in shiftwork, because they may have got used to a lowered level of well-being (Spelten et al. 1993).

In addition, job-related diseases cannot be defined by simple cause-effect relationships. They are usually multifaceted in nature and have risk factors that are not necessarily directly related to shiftwork but also to the working situation, and the individual person and their lifestyle (Costa 1996, Rutenfranz et al. 1985), compare for instance the discussion on pregnancy risks in chapter 4. Especially individual differences in tolerance to shiftwork need to be considered. Age and gender were mentioned as prime factors. The process of maladaptation or intolerance to shiftwork may proceed at a different rate in individual cases so that complaints and/or illnesses can appear at different stages in the lifetime of the worker. This will add to the higher inter-individual variability found in this area (Costa 1996). In short: age and gender influences may make the process of (mal)adaptation less straightforward. For example in the case of female shiftworkers, their sleep duration appeared to be shortest when they have younger children. In work years these are more likely to be the middle years and not the latter work years, or the first 5 years. To add to the complexity of the situation, it has also been shown that this effect may be obscured again by the fact that some women actually choose shiftwork because it fits in best with the fact that they have younger children at home. Choice may well buffer the negative effects of for example reduced sleep duration (Barton 1994).

And finally, the multifactorial nature of the diseases found to be related to shiftwork needs to be taken into account. In this respect shiftwork has to be seen as one of the many risk factors which may contribute to the development of ill-health or disease (Costa 1996).

In all, shiftwork is likely to be associated with health problems. The extent to which and the influence on this relation of sleep problems remain to be investigated. The situation is complicated by the limits imposed upon adaptation and the adverse effects of ageing. This has led to the, almost simultaneous, development of two theories concerning the occurrence of health complaints in relation to persistent exposure to shiftwork.

6.3.2. Two models

A cumulative model of health and well-being complaints

The absence of complete adjustment combined with ageing (which is associated with an increased intolerance to shiftwork) have led to the development of a cumulative model of health complaints of shiftworkers, addressing the chronic effects of shiftwork (Haider et al. 1981). The model was developed based on elaborate statistical analyses of variables relevant to shiftwork research. The model proposed that simple causal chains between shiftwork and health should not be expected. Rather it suggests that shiftworkers are exposed to a large number of situational and biological factors whose stabilising or destabilising effects are relative, interacting, time contingent, and sequential. The interaction between health and these intervening variables seems to develop through four phases: an adaptation phase, a sensitisation phase, an accumulation phase and finally, a manifestation phase. Although no simple causal chains are to be expected, the model does assume linearity, i.e. a progression of one stage to the next. The worker is said to pass through these four phases and at some point they will reach a tolerance limit where disturbance is probable, coping with shiftwork becomes impossible and drop-out is likely. The 'successful' shiftworker reaches the Manifestation phase after about 40 years of shiftwork, when coping with shiftwork deteriorates rapidly and health problems are most likely to occur. Individual differences in stress tolerance or ability to develop coping mechanisms result in drop-outs at all phases in this developmental process. It is proposed that at each phase different variables are the most important factor for tolerance, and different coping skills must be developed if complete intolerance is to be delayed. The different phases are as follows.

The first phase is called the Adaptation phases and comprises the first 5 years of working shifts. Within the first 5 years of shiftwork, novelty effects have to be overcome and adaptation and habituation have to be gained with regard to the workplace, work environment, work tasks and colleagues as well as to shift dependent rhythm alterations. Furthermore, the family situation (marriage, babies, children, need for own flat or house) and social situations (limitation of personal and social freedom) alter markedly. It seems clear that the quality of sleep, family life and social activities, together with work strain have the strongest influence on health and well-being during this adaptation phase. Consequently, in this first phase, the main covariation was between sleeping behaviour, work strain, social activities, and health state.

The next phase, called the Sensitisation Phase comprises the next 5-20 years of working shifts. From the 5th to 20th year of shiftwork the life circumstances of a shiftworker can be described as a cumulated need for and pressure to achieve improved family conditions (children in school, house-building, financial problems) and working conditions (engagement in work for promotion and for financial improvement). According to the level of success in these areas, and to the success in developing coping strategies, attitudes towards shiftwork change. Thus, in the sensitisation phase attitudes towards shiftwork, and satisfaction with both shiftwork and family and social life, play an important role in the incidence of health and well-being problems. In this phase, the variables 'attitudes towards shiftwork', 'job satisfaction', and 'family situation' became highly important. During this phase, the variables 'sleeping behaviour', 'risk factors', and 'Morning-Evening Type' also started to increase in importance. In all, job satisfaction, career development, financial stability, and family growth appeared to be the most important factors.

The next phase is the Accumulation Phase, referring to 20-40 years of working shifts. From about the 20th year of shiftwork onwards, family, living, financial, and social situations seemed to remain roughly constant, or to improve. However, risky behaviour seemed to develop, environmental hazards accumulate, and the ageing factor played an important role. Thus, in this period, sleeping behaviour, risk factors and Morning-Evening Type together with attitudes towards shiftwork had the greatest power in predicting health state, whereas the other variables dropped in importance. This dichotomised effect is characteristic of this third phase. In this phase, biological ageing processes started to play a major role as the hazards of risky coping strategies begin to accumulate and preventive medical treatment may be needed.

The final Manifestation Phase, after about 40 years in shiftwork, marks the point at which it became clear that the shiftworker has not been successful in his or her effort to adapt to work on the night shift. At this time, disorders and disease manifest their highest frequency in shiftworkers. At the end of the accumulation phase and in the following manifestation phase (40+ years in shiftwork), the gastrointestinal disorders and diseases (chronic gastritis, gastric and duodenal ulcer) reached their highest frequency in shiftworking populations (Haider et al. 1981, Rutenfranz et al. 1985, Tepas et al. 1993).

Shiftwork Maladaptation Syndrome

A few years after the development of the cumulative health problems model, first mention is made of the Shiftwork Maladaptation Syndrome (SMS, Moore-Ede et al. 1987) which refers to the case of shiftworkers who never adjust to their work routine or who may decompensate with ageing (Moore-Ede et al. 1987). From 5 to 20% of shiftworkers have disproportionate symptoms of illness when beginning on shiftwork, especially with rotating schedules. Some symptoms resulting from circadian rhythm disruption are likely to occur in everyone when beginning shiftwork, but most workers adjust, at least partially, so that they have no or only mild symptoms. The worker with SMS however, never adjusts or may decompensate with ageing. Manifestations of SMS include a combination of symptoms and they get worse with time. Thus the worker with SMS has a syndrome consisting of:

- Sleep disturbance and chronic tiredness
- Gastro-intestinal complaints such as heartburn, constipation, diarrhoea
- Increased alcohol or drug use, usually related to self-treatment of insomnia
- Higher rates of accidents or near misses
- Depression, fatigue, mood disturbance, malaise, personality changes
- Interpersonal relationship difficulties.

Risk factors for SMS include age past 40 year, living with people who pursue a normal daytime routine, and poor tolerance of circadian rhythm disruption (Scott & LaDou 1990).

6.3.3. Specific health problems related to shiftwork

Having considered theories on the development of health complaints, now the evidence of a relation between shiftwork and specific health complaints will be considered. The lowering of well-being appears to result mainly from the disturbance of sleeping and eating habits. Although the need for sleep varies considerably across individuals, and with age, the normal amount is considerably longer than that which is normally achieved with night work. Mortality studies of shiftworkers are rare. Taylor and Pocock (1972) is an exception. They found no differences in mortality rate between shiftworkers and dayworkers, but shiftworkers who had given up shiftwork prematurely did show a higher mortality rate. The evidence that shiftwork causes specific illness is limited, but shiftworkers do have more health related complaints such as digestive problems, chest pain, wheezing, nervousness, colds and fatigue (Scott & LaDou 1990). There is increasing evidence that in the long run shiftwork may produce more severe troubles, which can result in psychosomatic illnesses that affect chiefly the gastrointestinal, the nervous and to a lesser extent the cardiovascular system (Costa 1996, Waterhouse et al. 1990). The main health and well-being concerns are discussed in more detail below.

Sleep loss

This is accepted as a major problem for shiftworkers and is considered to be a negative health outcome. The nature and frequency of sleep problems have already been discussed. It is important to note that in this study, sleep problems are seen as a result of shiftwork (i.e. an outcome) but are also considered to *precede* other health problems or at least influence or aggravate them.

Chronic Fatigue

Fatigue is strongly associated with shiftwork. Fatigue can be seen as a short term consequence of disrupted sleep, linked to reduced alertness and performance, as was discussed in the previous chapter. However, it has been shown that shiftworkers do not adapt to their situation in the sense that their fatigue symptoms, initially associated with disrupted sleep, disappear. Rather, persistent fatigue, in combination with other health symptoms, is seen as an indication of maladjustment or intolerance to shiftwork and can be considered as a precursor to more serious health problems (Reinberg et al. 1983). Chronic fatigue has been acknowledged to be one of the negative health outcomes of shiftwork (Costa 1996).

A reminiscence study of policemen retired from shiftwork looked at the possibility that shiftworkers, when on shiftwork, underestimate the problems they experience. This study showed that especially scores on a Chronic Fatigue scale together with scores on the General Health Questionnaire showed most markedly that the policemen had underestimated how they felt when they were still working shifts. In retrospect, they realised that they had felt more chronically tired (Spelten et al. 1993).

General well-being and neurological complaints

Studies regarding these complaints have provided evidence for a greater tendency towards general malaise in shiftworkers than in day workers. A persistent state of fatigue, and constant disturbances of sleep, associated with more severe disorders of the nervous system such as changed behaviour patterns, neuroticism, anxiety, or depression are frequently found in shiftworkers, particularly those with night work. The frequency with which disorders are reported differs widely among studies. It is also unclear which physiological and biochemical changes produced by shiftwork are exacerbated by social factors in contributing to this result (Waterhouse et al. 1990).

Neuroticism has often been seen as a predictor of tolerance to shiftwork. Yet, there is evidence to suggest that it may behave more as an outcome measure, and should thus be included when considering health complaints resulting from shiftwork (Bohle & Tilley 1989).

Digestive complaints

Evidence has confirmed that shiftworkers have an increased incidence of these disorders. After sleep problems, gastro-intestinal disorder is one of the most frequently recorded difficulties among shiftworkers. According to various studies from 20% to 75% of shiftworkers with night work (compared to 10-25% of dayworkers or shiftworkers without night work) complain of disturbances in appetite, bowel irregularity with prevalent constipation, dyspepsia, heartburn, abdominal pains, grumbling or flatulence. Many workers may also develop serious diseases such as chronic gastritis, gastroduodenitits, and peptic ulcer.

The causes of this are likely to be multiple, but diet, smoking, drinking alcohol and general stress have all been suggested, in addition to irregular mealtimes. The relative contribution of each factor remains to be determined (Costa 1996, Waterhouse et al. 1990).

Cardiovascular complaints

Waterhouse et al. (1990) concluded that the evidence in favour of the view that shiftwork is associated with an increase in cardiovascular disease is now becoming more difficult to dismiss as inconclusive than was the case in a similar review in 1978 (Harrington 1978). However, Costa (1996) stated that the degree of association between shiftwork and actual cardiovascular disease remains controversial. But, according to Costa, it is clear that the stress caused by shiftwork can have adverse effects on the cardiovascular system both through direct mechanisms as well as by indirect influences.

Possible causes are not yet clear. Possibilities include increase in body mass, blood pressure and smoking. Especially smoking has been reported to have a higher incidence among shiftworkers compared to dayworkers, however information on actual smoking habits of in particular shiftworkers with cardiovascular disease seems to be sadly lacking (Costa 1996). At any rate, an increased risk for cardiovascular complaints among shiftworkers cannot yet be excluded.

6.4. Gender roles, age, and health and well-being

With regard to gender and health, it has been noted that women overall report more health complaints. Several explanations have been offered for this phenomenon, e.g. the tendency for women to more readily report complaints or to be more attentive to changes in their well-being, or to be more perceptive of symptoms (Gijsbers van Wijk 1995). However, these are not necessarily related to sleep loss or to domestic commitment in relation to work.

With age, irrespective of gender, people tend to report more health complaints. Increasing age has been associated with increasing health complaints, pointing to a cumulative effect. Explanations are often offered in terms of biological ageing and are not necessarily associated with higher levels of sleep problems.

When looking at gender and well-being, it could be assumed that a lowered well-being of women is more likely to be found during the child raising years and even more so for women who choose to work shifts because of their younger children, because of reduced sleep duration. Therefore, although cumulative health complaint models, such as the Austrian Model, seem to assume a more linear decline in health, it could well be that this situation is less linear in the case of these women.

With regard to age and well-being, a gradual lowering of well-being with advancing age is assumed, but this often applies to after-retirement age.

Scott and LaDou (1990) singled out older workers and women with young children as groups particularly prone to sleep deprivation and on the increase in the workforce. It remains to be seen, however, if there are strong additional health implications associated with this sleep deprivation, other than the effects associated with shiftwork, sleep and age in general.

6.4.1. Gender roles, age and chronic fatigue

There is no well-established relationship between fatigue and either gender roles or age. In chapter 3, it was shown that gender roles have been associated with increased fatigue, most frequently as a result of reduced sleep quantity and/or quality. Most notably, women with young children are more likely to report more fatigue complaints. This finding was reconfirmed in a nation-wide Dutch study, looking at fatigue in the general population (Bensing & Schreurs 1995). In this study, persistent fatigue was also associated with reduced health. In general, evidence of a relation between age, gender roles and fatigue seemed to be circumstantial. Associations are indirect: women with young children are more likely to report fatigue mostly as a result of sleep problems. Equally, it can be assumed that older people with sleep problems will report higher levels of fatigue. And since older age is associated with increased sleep problems, it would follow that older people might report more fatigue.

6.5. Literature summary

Sleep problems and reduced sleep are associated with increased morbidity and even with mortality (Kripke et al. 1979). The main manifestation of chronic sleep problems is a feeling of chronic fatigue. The link between health and sleep problems is often circumstantial and mediated by individual differences.

Health problems of shiftworkers have been established even when the exact magnitude of the contribution of shiftwork cannot always be easily established. A cumulative model of health complaint over time for shiftworkers has been developed. In addition, adverse effects of shiftwork are generally accepted under the term 'shiftwork maladaptation syndrome'. It is not entirely clear what the standpoint in relation to both models is with regard to tolerance to shiftwork. The Austrian Model seems to assume that intolerance in inevitable, whereas the underlying assumption of the SMS seems to be that some workers do adjust and others do not.

The influence of individual differences needs to be taken into account. Both the Adaptation Phase and the Sensitisation Phase may well be more influenced by the presence of small children, in conjunction with this being a reason for working shifts, for female shiftworkers. These years may be more cause for concern in terms of health and well-being for women compared to men. This may refer to some of the individual variation the authors of the model allow for.

The following health complaints have been shown to be associated with shiftwork: sleep problems, chronic fatigue, general lowering of well-being and possible increased neuroticism, digestive or gastro-intestinal problems, and cardiovascular problems (Bohle & Tilley 1989, Costa 1996, Glazner 1991, Waterhouse et al. 1990). The extent to which shiftworkers actually suffer from these complaints remains difficult to establish because of the healthy worker effect (Knuttson & Åkerstedt 1992) and because of individual differences (Costa 1996). The healthy worker effect assumes that only those persons who can stand the disruption will stay in shiftwork for more than say 5 years. Therefore, in research, mostly non-representative samples are considered. In relation to this effect it has been shown that shiftworkers possibly underestimate their problems as a result of a gradual habituation to a lowered level of health and well-being, i.e. an inadequate comparison to the situation before they worked shifts (Spelten et al. 1993). Moore-Ede and Richardson (1985) also assumed that the seriousness of the problem is underestimated because shiftworkers who have serious problems adjusting move to day work; shiftworkers tend to visit physicians less than dayworkers; and the health effects of different shift schedules vary considerably.

Evidence of an accumulation of health problems for shiftworkers in general was found. Less substantiated evidence was found for the added risks for female shiftworkers who have been frequently found to report reduced sleep duration, mostly related to domestic commitment. Ageing, the other individual difference factor involved, clearly does increase health problems, adding to the notion that older shiftworkers experienced more problems. No buffering effect for experience was found. The question remains what the contributing factor is of sleep in relation to an increase in health problems. This is part of the question addressed in this study. This, at the same time, addresses the issue of sequencing. Little attention has been paid to aggravation of health problems as a result of persistent sleep problems. After all, sleep deprivation is a more immediate result of working shifts, whereas health problems are argued to build up over time. In this study, it has been assumed that sleep problems contribute to health problems and thus precede health problems, rather than co-occur together with other health outcome measures. And thus if periods can be distinguished in which there is a higher level of sleep problems; more health related problems would be expected to occur. The question remains when. In a linear accumulation they would occur more likely at a later stage of exposure. In a model that allows for compensation or variation on the basis of individual differences, this may be less straightforward.

Finally, the link between acute effects (such as reduced alertness) and chronic effects was not addressed because no literature relevant to this relationship could be traced.

6.6. Analysis

The analysis section will focus on the health outcome measures included in this study and their relation to sleep, gender roles and age. In addition, the relationship between acute and chronic effects will be considered. The following measure were included to measure chronic effects: a chronic fatigue scale, a questionnaire focusing on cardiovascular and gastro-intestinal health problems, the GHQ-12 to measure general health and well-being and an additional scale to measure neuroticism. All measures are described in appendix I.

Analyses concentrate on the effect of the age-sleep association on more chronic complaints. In line with previous chapters, regression analysis was used. Sleep need was again included as a control variable. First of all, correlations were calculated between the outcome measures, in order to look at how related they were. The results, shown in table 6.1. indicate that fatigue is relatively strongly associated with all other outcome measures. General health and well-being, as measured by the GHQ was associated with fatigue and neuroticism and to a lesser extent with cardiovascular and digestive complaints. Cardiovascular complaints and digestive complaints were again moderately correlated among themselves and with fatigue. Both had low correlations with GHQ and cardiovascular complaints also had low correlations with neuroticism, which was moderately to highly correlated with digestive complaints.

Table 6.1:
Correlations of the outcome measures

Variable	1	2	3	4	5
1. GHQ	-----				
2. Fatigue	.368	-----			
3. Neuroticism	.459	.434	-----		
4. Cardiovascular complaints	.288	.353	.299	------	
5. Digestive complaints	.294	.361	.362	.368	-----

all correlations significant at a $p<0.001$ level

6.6.1. Chronic effects

Following the correlations, regression analyses were conducted. The following outcome measures were included as dependent measures: GHQ, fatigue, neuroticism ('neuro'), cardiovascular complaints ('cardio'), and digestive complaints ('digest'). Sleep quality and quantity, age, number of dependants and domestic considerations for working shifts were used as predictors. Work-nonwork conflict was also added, but here results refer to a smaller sample, see chapter 4.

Analyses were conducted separately for permanent night nurses and rotating shift nurses and only included female shiftworkers. The results are shown in tables 6.2.a through 6.3.b.

Table 6.2.a:
Regression analysis of age, gender, gender roles
and sleep on outcome measures for rotating nurses: beta weights

Variable	Fatigue	GHQ	Neuro	Cardio	Digest
Sleep difficulties					
morning	.222***	.150**	.155**	.160**	.117*
afternoon	.133*	n.s.	n.s.	n.s	.139*
night	n.s.	.158**	.158**	n.s.	.137*
rest day	.218***	.155**	n.s.	n.s.	n.s.
Sleep duration					
morning	n.s.	n.s.	n.s.	n.s.	n.s.
afternoon	n.s.	n.s.	n.s.	n.s.	n.s.
night	n.s.	n.s.	n.s.	n.s.	n.s.
rest day	n.s.	n.s.	n.s.	n.s.	n.s.
Age	n.s.	n.s.	n.s.	.119*	n.s.
Dependants	n.s.	n.s.	n.s.	n.s.	n.s.
Domestic reason	n.s.	n.s.	n.s.	n.s.	n.s.
R^2	.268	.103	.109	.044	.105

significant difference: * p <= 0.05 ** p <= 0.01 *** p<= 0.001, n.s.: not significant

Table 6.2.b:
Regression analysis of age, gender, gender roles (including work-nonwork conflict)
and sleep on outcome measures for rotating nurses: beta weights

Variable	Fatigue	GHQ	Neuro	Cardio	Digest
sleep difficulties					
morning	.217**	n.s.	.207**	.218**	.200**
afternoon	n.s.	n.s.	n.s.	n.s	n.s.
night	n.s.	n.s.	n.s.	n.s.	.236**
rest day	.255**	n.s.	n.s.	n.s.	n.s.
sleep duration					
morning	n.s.	-.148*	n.s.	n.s.	n.s.
afternoon	n.s.	n.s.	n.s.	n.s.	n.s.
night	n.s.	n.s.	n.s.	n.s.	n.s.
rest day	n.s.	n.s.	n.s.	n.s.	.184*
age	n.s.	n.s.	n.s.	.177*	n.s.
dependants	n.s.	n.s.	n.s.	n.s.	n.s.
domestic reason	n.s.	-.145*	n.s.	n.s.	n.s.
work-nonwork c.	.150*	.181*	.150*	n.s.	n.s.
R^2	.292	.100	.150	.063	.112

significant difference: * p <= 0.05 ** p <= 0.01 *** p<= 0.001, n.s.: not significant

Table 6.3.a:
Regression analysis of age, gender, gender roles
and sleep on outcome measures for permanent night nurses: beta weights

Variable	Fatigue	GHQ	Neuro	Cardio	Digest
sleep difficulties					
night	.269**	.321**	.356***	.176*	.345***
rest day	.248**	n.s.	.250**	.330***	.224**
sleep duration					
night	n.s.	n.s.	n.s.	n.s.	n.s.
rest day	n.s.	n.s.	n.s.	n.s.	n.s.
age	n.s.	n.s.	n.s.	.160*	n.s.
dependants	n.s.	n.s.	n.s.	n.s.	n.s.
domestic reason	n.s.	n.s.	n.s.	n.s.	n.s.
R^2	.204	.094	.224	.189	.188

significant difference: * p <= 0.05 ** p <= 0.01 *** p<= 0.001, n.s.:not significant

Table 6.3.b:
Regression analysis of age, gender, gender roles (including work-nonwork conflict)
and sleep on outcome measures for permanent night nurses: beta weights

Variable	Fatigue	GHQ	Neuro	Cardio	Digest
sleep difficulties					
night	.263*	.427**	.378**	.319*	.356**
rest day	.261**	n.s.	n.s.	n.s.	n.s.
sleep duration					
night	n.s.	n.s.	n.s.	n.s.	n.s.
rest day	n.s.	n.s.	n.s.	n.s.	n.s.
age	n.s.	n.s.	n.s.	.326**	n.s.
dependants	n.s.	n.s.	n.s.	n.s.	n.s.
domestic reason	n.s.	n.s.	n.s.	n.s.	n.s.
work-nonwork c.	.256**	n.s.	n.s.	n.s.	n.s.
R^2	.388	.115	.164	.140	.107

significant difference: * p <= 0.05 ** p <= 0.01 *** p<= 0.001, n.s.:not significant

For both groups of nurses, sleep quality was the most important variable in relation to all outcome measures. More sleep difficulties were associated with more health complaints. Interestingly, the reported reduced sleep duration only had a very limited relationship with the health outcome measures in this study. Age was associated with an increase in cardiovascular complaints for both groups. Of the gender role variables, only work-nonwork conflict was associated with the outcome measures. This variable was related to increased fatigue and to lowered psychological well-being. No relation was found with the physical health outcome measures. Explained variance for all outcome measures was low, with the exception of chronic fatigue.

6.6.2. Link acute – chronic effects

The next step was to investigate the relationship between acute effects and chronic effects. Although there is no evidence in the literature of a clear relationship between acute and chronic effects, it still seemed interesting to test a possible relationship in the present sample. The SSI model assumes a relationship from acute effects to chronic effects. For this purpose, the measures for the acrophase, the mesor and the amplitude of alertness were used as predictors in a regression analysis. The results are reported in table 6.4. and 6.5. Results differed for the permanent night nurses and the rotating shift nurses. In all, however, explained variance was very low. For the permanent night nurses, the mesor and to a lesser extent, the amplitude measure were related to the outcome measures. Acrophase was not associated with any of the outcome measures. No association between cardiovascular complaints and alertness measures was found. For the rotating shift nurses, the alertness measures were associated with fatigue and the psychological well-being measures, not with the physical health measures. For the night shift, this applied to the mesor, for the afternoon shift this applied to the acrophase. Results for the morning shift were negligible.

Table 6.4.
Regression analysis of acrophase, mesor and amplitude on outcome measures for permanent night nurses/night shift: beta weights

Variable	Fatigue	GHQ	Neuro	Cardio	Digest
Acrophase	n.s.	n.s.	n.s.	n.s.	n.s.
Mesor	-.600***	-.409***	-.424***	n.s.	-.339**
Amplitude	-.282**	n.s.	-.265**	n.s.	-.230*
R^2	.165	.068	.080	----	.039

significant difference: * p <= 0.05 ** p <= 0.01 *** p<= 0.001, n.s.:not significant

Table 6.5.
Regression analysis of acrophase, mesor and amplitude on outcome measures for rotating shift nurses: beta weights

Variable	Fatigue	GHQ	Neuro	Cardio	Digest
Night shift:					
acrophase	n.s.	n.s.	n.s.	n.s.	n.s.
mesor	-.183*	-.196*	-.209*	n.s.	n.s.
amplitude	n.s.	n.s.	n.s.	n.s.	n.s.
Morning shift:					
acrophase	n.s.	n.s.	n.s.	n.s.	n.s.
mesor	-.245**	n.s.	n.s.	n.s.	n.s.
amplitude	n.s.	n.s.	n.s.	n.s.	n.s.
Afternoon shift:					
acrophase	.170*	.161*	.153*	n.s.	n.s.
mesor	n.s.	n.s.	n.s.	n.s.	n.s.
amplitude	n.s.	-.297*	n.s.	n.s.	n.s.
R^2	.150	.046	.054	----	----

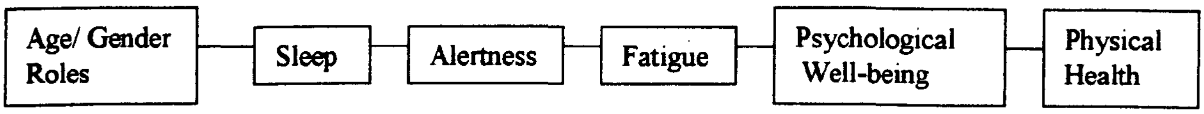
significant difference: * p <= 0.05 ** p <= 0.01 *** p<= 0.001, n.s.: not significant

6.6.3. Ordering in time

Finally, a complete sequence in time of the variables, as proposed in this thesis, was explored. In chapter one, a preliminary ordering was presented. The temporal ordering based on the model underlying the SSI was used. The chapter structure of this thesis was based on this model. Each chapter dealt with segments of this ordering. First, a relationship between age and sleep was investigated, and then attention was paid to the influence of shiftwork and gender. This was in turn followed by an investigation of, first, the acute effects of the previous relationships and then the chronic effects of this relationship. Finally the entire sequence for the two groups of shiftworkers will be explored. Based on the SSI-model, and on the path analysis results reported in Barton et al. (1995), an attempt to model the temporal ordering of the relationship between age, sleep, gender roles, acute, and chronic effects was made. With the data being only cross-sectional, the results need to be treated with caution and should not be seen as a causal ordering. Rather, associations between variables were investigated. The model itself specifies a theoretical progression of the more short term-acute effects through to the more chronic effects. Thus progression from sleep disturbances through reduced alertness, through chronic fatigue, through lowered psychological well-being to impaired physical health. A form of path analysis, using hierarchical regression (Barton et al. 1995, Orbell et al. 1996) was employed. This technique was chosen instead of more sophisticated techniques such as structural equation modelling or Lisrel analyses. These techniques would have required a severe reduction in the model or ordering investigated. Previous research provided limited ground for such a reduction. Therefore it was decided to explore the complete temporal ordering rather than to test a severely reduced model.

The proposed ordering (chapter 1) was adjusted, based on the results in the previous chapters. Most importantly, this study only dealt with shiftworkers.

This became the starting point for the ordering, followed by the impact of age, sleep, and gender roles, and then to acute and chronic effects. Adjustments resulted in the following ordering to be explored.



The analysis was conducted separately for the permanent night nurses and the rotating shift nurses and in the latter group, again separately for the three shifts involved. For both groups, the analyses were conducted with the Follow-Up data set. The resulting four models, with beta-weights specified can be found at the end of the chapter, following the discussion. Arrows are used to indicate which variable was used as a dependent variable (the arrow is pointed to this variable) and which variable was used as a predictor (the other end of the line). Four different models were presented. A number of consistent links in all four models were found. These were the relationships between age and cardiovascular complaints, between work-nonwork conflict and well-being, between sleep duration and the mesor, between sleep difficulties and chronic fatigue, between chronic fatigue and cardiovascular complaints, between chronic fatigue and neuroticism, and between digestive complaints and cardiovascular complaints. Interestingly, acrophase was almost not related to any of the other variables in all four models.

Differences were also found for the four subgroups. The more prominent associations are mentioned here. For the permanent night nurses, age, domestic commitment as a reason for shiftwork, and the number of dependants all were associated to the sleep measures. Work-nonwork conflict was only associated with chronic fatigue. Sleep difficulties had a clearer association with outcome measures, compared to sleep duration. Relatively few associations with the acute measures were found, either way. Of the more chronic measures, chronic fatigue was associated with most measures on either side in the temporal ordering.

For the rotating shift nurses, for the night shift, both the presence of dependants and domestic commitment as a reason for shiftwork, were clearly less relevant variables in this sample. Here also, sleep difficulties had a clearer association with the effects measures, compared to sleep duration. And chronic fatigue was associated with almost all variables. For the morning shift, only work-nonwork conflict was associated with the sleep measures. Again, chronic fatigue is associated with most variables. For the afternoon shift, the results were similar.

With regard to the acute effects, the only association for the acrophase was with sleep difficulties for the afternoon shift. With the exception of the morning shift, sleep duration affected both the mesor and the amplitude. Sleep difficulties were associated with the mesor for the night shift in both groups of nurses. In turn, the alertness measures were most strongly associated with chronic fatigue, with the exception of the afternoon shift, where the amplitude appeared to be associated with neuroticism.

In all, the ordering is in line with the underlying SSI model. An exploratory temporal ordering of sleep, through, fatigue, through well-being, through physical health was supported by the data. Also, the association between individual difference measures and sleep was largely supported.

6.7. Discussion

Here, attention was paid to the more chronic effects on health and well-being of affected sleep. Because of the nature of the sample, the emphasis was on shiftwork related elements of this relationship. From the literature it became clear that shiftwork is associated with negative chronic health effects. Shiftwork is commonly considered to be a risk factor for cardiovascular and digestive complaints and is strongly associated with a lowered level of well-being. Health and well-being effects are in fact assumed to be of such a nature that a course of life model has been developed in which is assumed that health complaints accumulate and will inevitable manifest itself after some 25 years in shiftwork. In addition, the establishment of a Shiftwork Maladaptation Syndrome confirms the association between shiftwork and health complaints. In research, sleep problems are often considered together with the other health complaints, but there is sufficient reason to assume that sleep problems, given their imminent nature, may precede and affect health complaints. If this were the case, factors affecting sleep would in turn become more relevant to consider in relation (indirect) to health complaints. On theoretical grounds it could then be assumed that groups with specific sleep problems might then in turn be at risk of developing health problems. Examples of these groups would be women and older workers.

Regression analyses showed that it was in fact sleep quality more than anything that was associated with the outcome measures. Surprisingly, reduced sleep duration, which was reported by nurses and related to gender roles was not related to the health outcomes in this study. This is remarkable because a relationship between reduced sleep duration and reduced health and well-being has been assumed in the literature (e.g. Kripke et al. 1979). In previous chapters, it was shown that both age and gender-role aspects influence sleep quality and sleep duration, which now in turn were shown to be directly related to the outcome measures.

The results of the analyses to this point supported the idea that a temporal ordering may be developed in which age and gender-role aspects influenced sleep, which in turn affected health and well-being. This ordering could consider that, even if no direct link was found between age and gender-roles on the one hand and health and well-being on the other, it could well be that this association was indirect via sleep quality and, possibly, duration. A path analysis resulted in an exploratory temporal ordering which largely supported the underlying SSI model and the theoretical assumptions of previous shiftwork models (Barton et al. 1995). Age and gender role variables were associated with sleep difficulties and sleep duration, which in turn were associated to acute and chronic effects of reduced and impaired sleep.

The results found for the acute effects, finally, were informative because only a few expectations of associations with the alertness measures were formulated on the basis of the literature. The results showed a slightly more frequent association with sleep duration. With regard to the health measures, alertness variables were only related to chronic fatigue. Thus, as could be expected, reduced sleep duration has a clear association with subsequent reduced alertness, more so than increased sleep difficulties. In turn, reduced alertness was associated with chronic fatigue, which in turn was associated with other chronic health complaints. The results thus supported the thought underlying the SSI model that there is a link from acute to chronic effects. In this sample this link was via chronic fatigue.

In the next and final chapter, all results will be discussed and related to previous research findings.

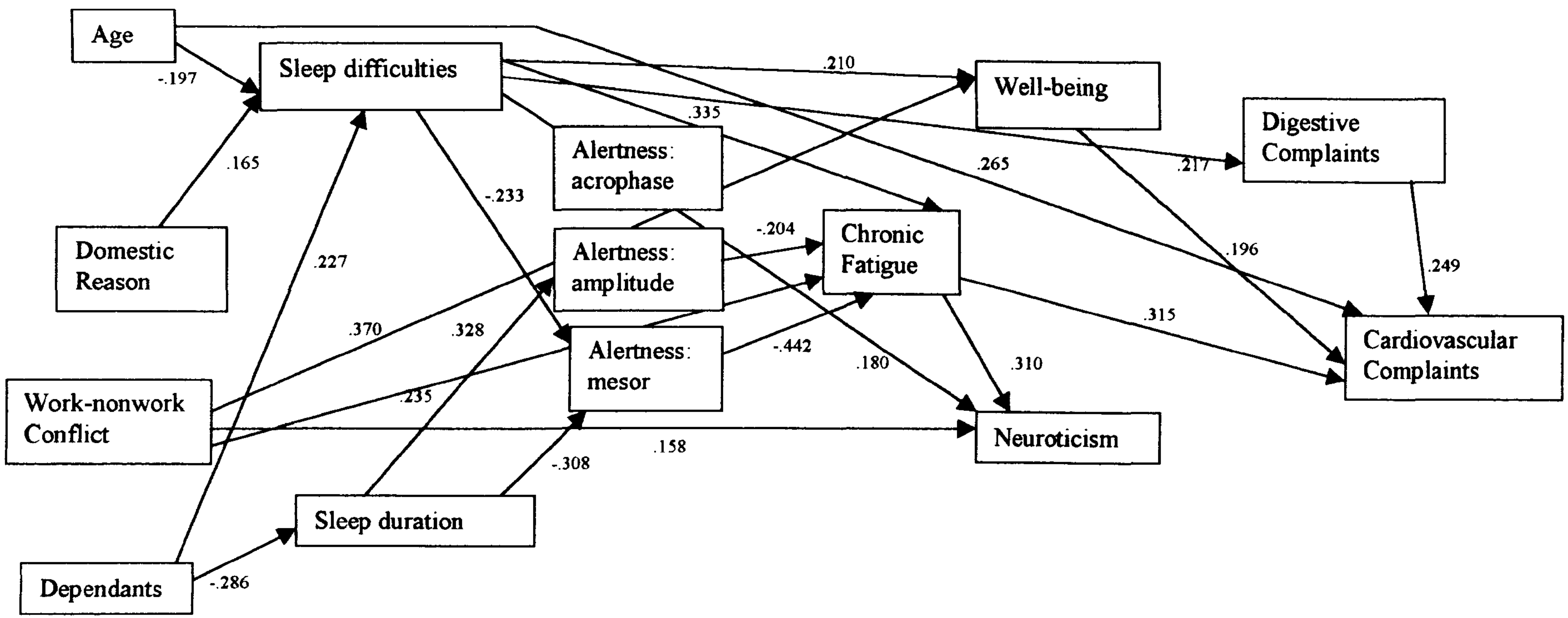


Figure 6.1.: Temporal ordering for the permanent night nurses/night shift

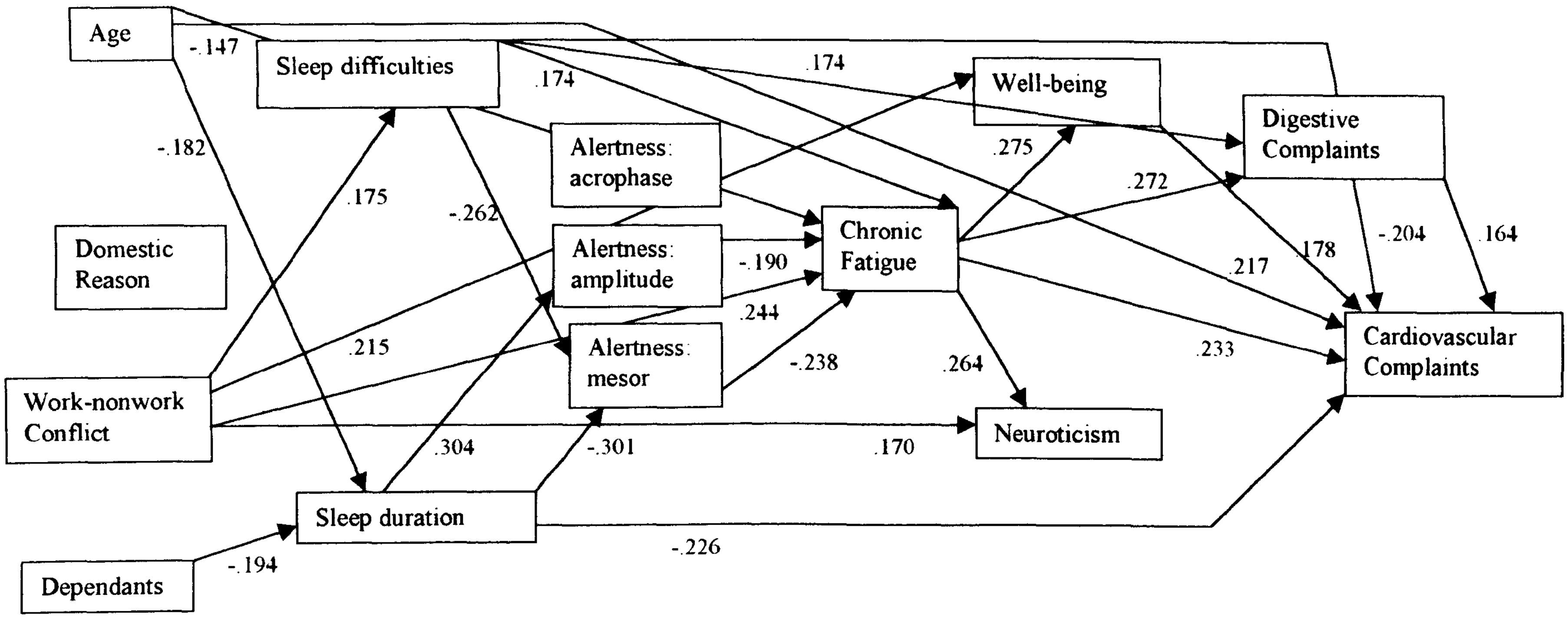


Figure 6.2.: Temporal ordering for the rotating shift nurses/night shift

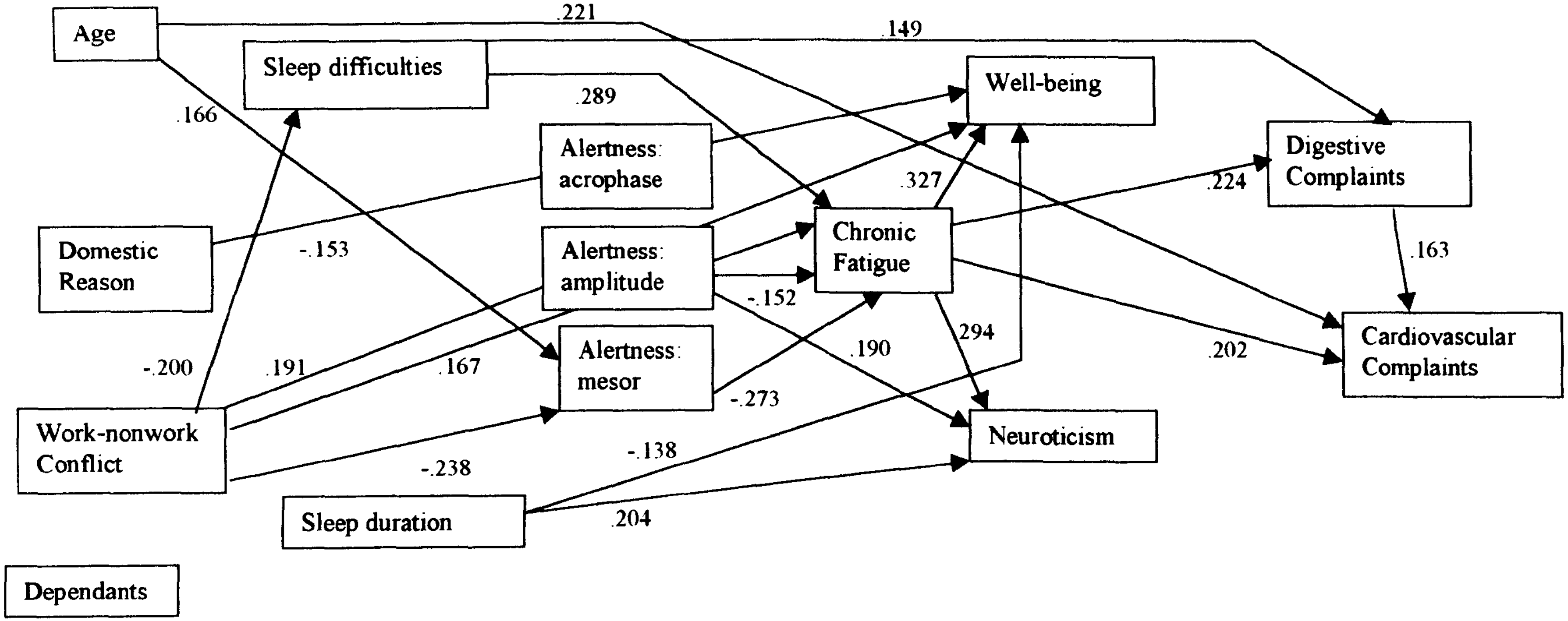


Figure 6.3.: Temporal ordering for the rotating shift nurses/morning shift

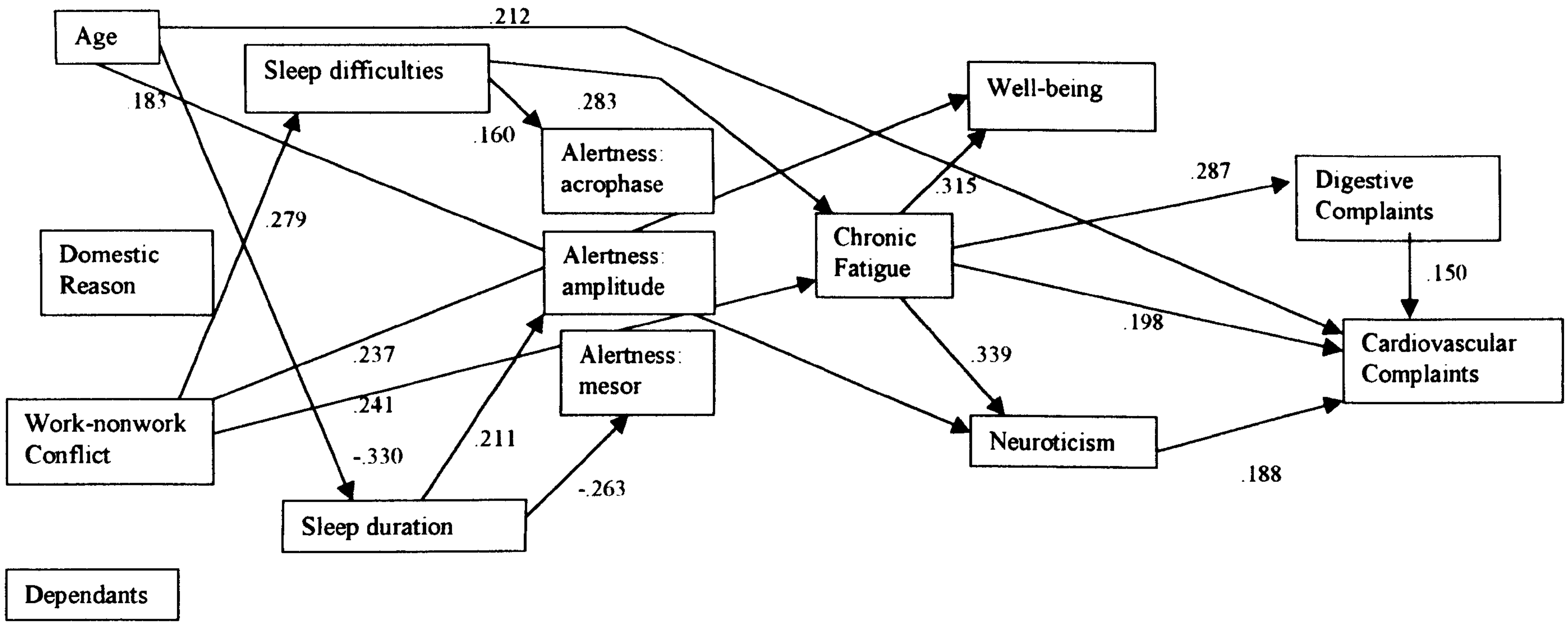


Figure 6.4.: Temporal ordering for the rotating shift nurses/afternoon shift

7

SUMMARY AND DISCUSSION

7.1. Introduction

In this study, the relationship between age, sleep, and health in a group of shiftworking nurses was investigated. The study forms part of a larger study into the health and well-being of shiftworking nurses and midwives in England and Wales (Department of Health, 1993).

The nurses in this study predominantly worked two shiftwork systems: either permanent night work or rotating shiftwork. In chapter 3 it was explained that, irrespective of the system worked, shiftwork is known for its negative effects on the sleep quality and quantity of the worker. In addition, research has shown that there is a build up of health complaints over time (Costa 1996, Waterhouse et al. 1990). Experience does not buffer against these effects of shiftwork and working shifts becomes increasingly difficult with advancing age. The affected sleep of shiftworkers is likely to contribute to the occurrence of health problems. This may be due to the age-related changes in our sleep pattern (Foret et al. 1981, Haider et al. 1981, Morin 1993).

The nurses in this sample were mostly women. As reported in chapter 4, research has shown that women in shiftwork report more sleep difficulties compared to men in shiftwork. The most vulnerable group appeared to be women who care for younger children (Gadbois 1981). In addition, women with childcare responsibilities sometimes choose shiftwork as a means to combine work and childcare responsibilities. Finally, with age, reported sleep problems of women increase more than those of men (Kripke et al. 1979).

Within this context two recent developments are important. First, shiftwork has become more accessible to women due to changes in the law with regard to night work. Second, the composition of the work force is changing. It is anticipated that the work force in the Western world is likely to become older and will have an increased participation of women (Scott & LaDou 1990).

Together, these issues draw attention to the relationship between age and sleep in women in shiftwork. Different aspects of this relationship have been studied, e.g. sleep and age, shiftwork and gender, and shiftwork and sleep. However, to our knowledge, attention has never been paid to the combination of all four aspects. Nor has the subsequent impact on health been considered.

For the present study, the following research questions were formulated:

1. Is there evidence of an age-related effect on sleep duration and sleep difficulties?
2. Is there evidence of an impact of shiftwork on the relationship between age and sleep?
3. Is there evidence of an impact of gender on the relationship between age and sleep?

4. Is there evidence of an effect on health and well being of the relationship between age, sleep, shiftwork and gender?

7.2. The impact of age on sleep duration and sleep difficulties

The literature review of chapter 2 showed that with advancing age, night time sleep became more fragile and polycyclic. Furthermore, older persons were more likely to be morning types. A change in sleep need was less well established. There was also doubt about the assumed negative relation between sleep and age, which may not allow for enough individual variation. The relationship between sleep duration and sleep difficulties was described as notoriously complicated and not always strong by some authors (e.g. Borbély 1987), where other authors assumed and found a strong link between the two variables (e.g. Escriba et al. 1992).

Analyses of the data first compared this sample to the literature findings. In line with the literature, an increase of morningness associated with age was found. In addition, a self-reported lower sleep need for older nurses was also found, indicating that at least the perceived sleep need of this sample reduced with age. Sleep duration and sleep difficulties were only highly, negatively, correlated for sleep on a night shift.

Looking at age and sleep, a consistently high negative correlation for sleep duration with age was found for all sleep with the exception of the morning shift. This finding confirmed the change in sleep quantity as reported in the literature: with advancing age, people sleep less. With regard to the morning shift, a further reduction seems unlikely because the sleep duration is among the shortest to start with. In addition, increased morningness may have affected this result. In this sample, sleep difficulties on a night shift appeared to reduce with advancing age. This result contradicts the dominant view in the literature.

Next, in order to assess the relative importance of the sleep-age link, the relationship between age and sleep was compared to the relationship between age and other outcome measures (such as cardiovascular complaints). The correlations between age and sleep duration were higher than the correlations between age and any of the other outcome measures, establishing the importance of the age-sleep link.

In summary, for sleep quantity results were found to be in line with the literature. For sleep quality, the results were less clear. The reported increase in insomnia for women over the age of 40 (Kripke et al. 1979) was not supported by our data. The results seemed to contradict a commonly held view in the literature. The unclear relationship between age and sleep difficulties gave rise to questions about factors moderating the relationship between age and the level of reported sleep difficulties in this sample. In this sample two factors may act as moderators: shiftwork and gender. Their influence was next addressed.

7.3. The impact of shiftwork on age and sleep

The literature overview in chapter 3 showed that the effects of shiftwork on the (day) sleep of shiftworkers were surprisingly similar to the effects of ageing on sleep: sleep is more fragile, shorter, more easily interrupted, and fragmented. It was assumed that the effects of age and shiftwork might well be additive, resulting in even poorer sleep of older shiftworkers. Experience did not seem to counteract age in this respect. Problems in adjusting to shiftwork at an older age have also been associated with accumulated negative health effects. Finally, the shift system worked also had a different impact on the sleep of the worker.

With regard to explanations offered for reduced tolerance to shiftwork with advancing age, both biological and social factors have been considered. However, it is interesting to note that most explanations fell within the realm of 'biological factors": reduced circadian control, increased morningness, and reduced circadian amplitudes. This may have been influenced by the preponderance of studies with male shiftworkers (Tepas et al. 1993).

The analysis showed that, for the present sample, the effect of shift system on sleep difficulties was even more marked than the influence of age. The results confirmed the relevance of adding the shift system component to the model to explain the relationship between age and sleep.

Two substantially different shift systems were worked: permanent night and rotating shifts. Analysis showed that the two groups of nurses also differed significantly on a number of demographic variables. Briefly, permanent night nurses were older, had shorter sleep duration but less sleep difficulties, experienced fewer problems in general and were more likely to have chosen shiftwork for domestic reasons. The results for sleep duration and sleep difficulties confirmed the less than straightforward relation between the two variables. In addition, their choice for nightwork may well have influenced the reduced levels of experienced problems, compared to the rotating shift nurses.

It was concluded that, next to age, shift system is an important variable, when considering sleep and sleep problems in this sample. However, the demographic differences between nurses in the two shift systems need also be taken into account.

7.4. The impact of gender and gender roles on age and sleep

In chapter 4, the literature review showed that women reported more insomnia complaints than men do. For sleep-related gender differences, both social and biological causes were suggested. Social differences were mostly related to differences in life style. Quite recent results indicate a larger role for biological differences than had been assumed to date. Research has found possible differences in the ageing of circadian rhythms between men and women (Monk et al 1995, 1996).

Reduced sleep duration for women was the most consistent gender difference in relation to shiftwork. In the literature, emphasis has been laid quite heavily on social factors in explaining this difference, i.e. reasons women have for choosing shiftwork, often related to their domestic commitment. This widened the view from gender to gender roles. In this respect, the roles that are traditionally attached to being a woman such as raising children and other domestic commitments are important factors to consider.

For the analysis, the gender comparison was hindered by the unequal group sizes in the sample: 1405 women versus 115 men. Possibly influenced by this size difference, only few gender differences were found: men slept less on morning shifts and experienced fewer problems related to night shift sleep. In addition, they were less likely to have chosen shiftwork to fit in with their domestic commitment and worked more hours per week.

Because a fair comparison on gender could not be made, further analysis was restricted to the female shiftworkers and focussed on gender role differences. Three variables related to gender role were considered: children (the number of dependants), choice (domestic grounds for working shifts), and conflict (experienced work-nonwork conflict). Analysis showed that, next to age, children had a clear negative impact on sleep duration. However, this variable less strongly influenced sleep difficulties. Contrary to the influence on sleep duration, the presence of children resulted in less sleep difficulties.

Interestingly, choice was associated with fewer sleep problems during night shifts, but with more sleep problems on rest days. Choice did influence sleep difficulties for both shifts. This may have been a confounded result. Permanent night nurses were more likely to have chosen shiftwork for domestic reasons. This probably explains the results for night shifts and rest days because these are the only two relevant shifts for this group.

Conflict had a clear impact on sleep difficulties: more conflict was associated with more sleep difficulties for all sleeps considered. No indication of a confounded result was found despite the fact that the rotating nurses experience significantly more work-nonwork conflict, compared to permanent night shift nurses.

Finally, the impact of shift system and gender roles was considered together. Shift system was no longer related to sleep duration but only to sleep difficulties. This confirmed that gender role factors are strongly related to the shift system worked. In all, the variables explain a reasonable percentage of the variance for sleep duration. Considerably less variance was explained for sleep difficulties. This may have been affected by the substantial differences between the two groups of nurses, since only results for the night shift and for rest day sleeps were found. Because of demographic differences between the two groups, further analyses were conducted separately for permanent night nurses and rotating shift nurses. Men were excluded from further analysis because of unequal group sizes.

7.5. The impact on alertness

In chapter 5, reduced alertness as an acute effect of sleep problems was considered. It was concluded that alertness is the most important psychological circadian rhythm. Alertness has been linked to performance and safety at work and has been used as a measure of adjustment of circadian rhythm in the case of shiftwork. There is sufficient evidence that shiftworkers experience reduced alertness as a result of their sleep deficit. The night shift is the most clearly affected shift, due to the combined effect of sleep deprivation and circadian rhythm disruption. Reduced sleep duration is the most common factor to explain reduced alertness, not reduced sleep quality.

Despite the relation between reduced sleep and older age, no ensuing link with reduced alertness in relation to age has been established. In general, in explaining reduced alertness, biological factors have received more attention than social factors. Most research has been with male shiftworkers resulting in little gender-oriented work. However, recently, Monk et al. (1996) have reported possible gender difference. Monk et al. concluded that the sleep and circadian rhythms of men and women do not age equally well: women seemed to fare better. In addition, the affected sleep of female shiftworkers with high domestic commitment has not been known to result in reduced alertness at work.

Analyses showed that the permanent night nurses rated their alertness significantly higher for the night shift, compared to nurses working rotating shifts. Additional analyses showed that reduced sleep duration was associated with reduced alertness. Next to sleep duration reported sleep difficulties seemed to have an equally strong relationship on reported alertness.

With regard to age, permanent night nurses who were on average older reported the highest alertness ratings. For the rotating shift nurses, only an interaction effect was found for age for the morning shift, with younger nurses reporting feeling less alert. This could be a reflection of the increased morningness tendency in older nurses, which would make older nurses feel more alert in the morning. Alternatively, this could be explained in terms of less adjustment of their social life to their work life of the working nurses (Folkard et al. 1978). With regard to gender roles, results indicated that rotating shift nurses with higher levels of conflict and with no children felt less alert. Both findings could be explained in terms of limited adjustment to their work routine of the younger rotating nurses with no dependants at home. This is in line with earlier findings in the literature e.g. Folkard et al. (1978). These results paint a picture of a younger nurse, working rotating shifts, with no children, higher levels of sleep difficulties and conflict, and shorter sleep duration, all of which resulted in reduced on-shift alertness.

Estimates for the acrophase, the amplitude, and the mesor for the alertness rhythm were calculated. These variables were used in subsequent regression analyses. The results confirmed the relevance of sleep duration as a factor affecting on-shift alertness. Less evidence was found for the influence of sleep difficulties on these dimensions of alertness. In addition, the influence of conflict and age was established which pointed to the relevance of choice and commitment.

Alertness may also be looked at in terms of adjustment to shiftwork (Folkard 1996a). The model presented by Folkard has been used to predict trends in adjustment. The results presented here seem largely in line with the results presented by Folkard (figure 2.12, p. 54), adding to the predictive strength of the model. In this respect, the higher alertness ratings of the permanent night nurses are also interesting. Folkard points to the relevance of the shift system under consideration. In general the rhythms in both body temperature and self-rated alertness (or sleepiness) typically showed very little adjustment to a rapidly rotating shift system and most adjustment on a permanent shift system. The higher alertness ratings of the permanent night nurses on the night shift, expressed in their higher mesor, could be seen as an indication of their better adjustment to shiftwork.

The higher alertness ratings of older nurses also lend support to the data reported by Monk et al. (1996), that older women seem to fare better. Although no gender comparison could be made, results did show that older female nurses reported higher alertness ratings compared to younger female nurses.

Overall, the results confirmed the importance of sleep duration as a predictor of subsequent on-shift alertness. Next, the results were in line with the predictive model for adjustment to shiftwork developed by Folkard and Åkerstedt (1992). Finally, the overall higher alertness rating of older nurses would fit in with results of Monk et al. (1996) and thus lend support to their idea that women may, in circadian terms, age differently, and better, compared to men.

7.6. The impact on health and well-being

Finally, the impact of age, gender roles, and affected alertness on the health and well-being of the shiftworker was considered. The literature review in chapter 6 showed that shiftwork is associated with negative chronic health effects, and with a lowered level of well-being. These complaints are considered to build up over time. In research, sleep problems are often taken together with the other health complaints, but there is sufficient evidence that sleep problems precede and affect additional health complaints. As a result, factors affecting sleep were found to be relevant in relation to health and well-being. Groups with specific sleep problems would thus be at risk of developing health problems, e.g. women and older workers.

Analyses showed that it was in fact sleep quality more than anything that was associated with reduced health and well-being. Surprisingly, reduced sleep duration was not related to the health outcomes in this study. This is remarkable because a relationship between reduced sleep duration and reduced health and well-being has been assumed in the literature (e.g. Kripke et al. 1979). Of the gender role variables, only conflict was directly associated with the well-being measures: more conflict was associated with higher levels of chronic fatigue for both groups of nurses. No association with the physical health measures was found.

Finally a temporal ordering was proposed in which age and gender-role aspects influenced sleep, which in turn affected health and well-being. This ordering could confirm that even if no direct link was found between age and gender-roles on the one hand and health and well-being on the other, it could well be that this association was indirect via sleep quality and, possibly, duration. A path analysis resulted in a temporal ordering which largely supported the underlying SSI model and the theoretical assumptions of previous shiftwork models (Barton et al. 1995). Age and gender role variables were associated with sleep difficulties and sleep duration, which in turn were associated with acute and chronic effects of reduced and impaired sleep.

The results for alertness confirmed the association with sleep duration. Alertness variables were related to chronic fatigue, which in turn was associated with other chronic health complaints. The results thus supported the assumed link from acute to chronic effects.

7.7. Limitations of the study

Before addressing the implications of this study, attention is paid to the limitations or boundaries of this study. The focus of the thesis is confined by the data of the Department of Health study. This implies certain limitations for the data at hand.

First of all, data collected reflect self-reported information. For example, sleep difficulties and sleep duration were self-reported. So called more objective measures, such as polysomnographic recordings, are not available. As a result, the findings of this study cannot be considered in relation to more objective measures. Equally, no physiological data are available to consider differences between the social or biological nature of results in more detail. A lot of the problems discussed in this thesis have both biological and social roots. At several points in this thesis, the relative impact of both factors is taken into consideration. It should be noted that this reflects a way of grouping, both factors are not mutually exclusive and are certainly interrelated. These limitations could be overcome by including more objective measures. However, more objective sleep studies have shown limitations as well (see chapter 2). As a result, it could be argued that looking at self-report data is in itself interesting enough depending on the research question that is being addressed.

The study dealt with a sample of shiftworkers, only. No comparisons could be made with day-workers; no other control group was available. This limits the generalisability of results. For the analyses presented here, variation within the group became the focus of attention, rather than variation between shiftworkers and e.g. a group of dayworkers.

More importantly, it needs to be noted that each of the two groups of shiftworkers was quite homogeneous. Also they differed significantly from each other on a number of relevant sociodemographic variables. Thus, differences found could reflect differences in the shift system worked as well as differences between the groups on these sociodemographic variables. This may be difficult to overcome in future studies, since the choice for a shift system and the demographic variables were strongly related. An alternative option would be to study the consequences of a shift system where all workers are required to work the same system.

In addition, most shiftworkers in this sample were experienced shiftworkers. Problems associated with initial adjustment to shiftwork are not likely to be an issue in this group anymore. However, since one of the variables was health problems that build up over time, this seems an inevitable consequence of the research question addressed.

With regard to age, it needs to be pointed out that the sample consists of people who are still in employment, and who will thus not be older than 60-65. Most ageing studies include older age groups. The results from this study regarding the effects of age need to be considered with this strong limitation in mind.

Another important limitation is the cross-sectional nature of the data in this study. As a result no causal inferences were made, only associations between variables could be investigated. All results should be interpreted as such. The obvious alternative is a longitudinal study.

The temporal ordering presented in this study, needs to be distinguished from testing a model. The ordering does not allow for cause or effect conclusions. Again, only associations between variables were investigated and no measure for the strength of the entire ordering could be calculated. This could be done with the use of additional techniques such a Lisrel or structural equation modelling.

With these limitations in mind, several of the implications of the study will now be discussed.

7.8. Implications

Sleep and age

The results showed that the influence of individual differences cannot be ignored in the relation between age and sleep. A general reduction of sleep duration with age was established. The relation with sleep difficulties or increased sleep complaints was less clear. This was explained in terms of the moderating influence of other variables, such as gender roles and shift system. It is important to note that other variables do not simply add to the negative relation between age and sleep, but could also buffer for some of the ageing effects. As such, the moderating effects of individual differences need to be taken into account.

Sleep: difficulties and duration

The results of this study stress the importance of distinguishing between sleep duration and self reported sleep difficulties, when studying sleep. In research it is not always clear whether the sleep complaints found refer to sleep duration or to sleep difficulties, or to both. The present study showed that sleep duration was found to be related to age in this sample, which was in line with the literature: increasing age was associated with reduced sleep duration. For sleep difficulties, this relationship was less clear. This finding support the idea that reduced sleep duration is not necessarily associated with an increase in sleep difficulties. Nor is, for that matter, a higher level of reported sleep difficulties associated with less sleep.

Tolerance, adjustment and survival

It has been shown that with increasing age circadian rhythms flatten, which should result in less tolerance towards shiftwork. However, this did not apply to the permanent night nurses in this sample. The results of this study contradict the commonly held belief that shiftworking women with children are worst off. The signalled problems of women in shiftwork are usually explained in terms of gender roles (a social rather than a biological explanation): more "burden", less sleep, more problems. However this does not apply to the permanent night nurses in this sample. It is in fact the group of younger nurses, without dependants, which seems to suffer most sleep problems. There are several possible explanations for this result. One is Monk et al.'s theory (1996) on survivors and stable rhythms, which has been discussed before, the idea being that especially older women age differently and better in circadian terms compared to men. Another explanation may be the notion of 'sturdy survivors' (Wedderburn and Robson 1990) or the 'healthy worker effect', both pointing to the survival population we are dealing with. In addition, the better tolerance of older shiftworkers in this sample could be the result of choice: permanent night nurses choose their shift system. Choice has been known to have a positive moderating effect on adjustment to night work (Barton 1994). This could also be phrased in terms of better adjustment of their private life to their work routine (Folkard et al. 1978) In this sense the concept of hardiness (Wedderburn 1995) may also be relevant. Hardiness is related to elements such as choice, control and commitment. It is assumed that these factors could have a positive effect on adjustment to shiftwork. Wedderburn quite rightly points to the cross sectional nature of the data and concludes that the causal direction could also be the other way round: the stress caused by having to adjust to the shiftwork could lead to a feeling of lack of control and reduced commitment. This, in turn, would describe the possible process signalled in the rotating shift nurses in this sample, who experienced higher levels of work-nonwork conflict.

As a minor comment, it is interesting to note that it is generally assumed that evening types adjust better to shiftwork. However, in this study, the permanent night nurses seemed better adjusted and they were also slightly more likely to be morning types, since they were older. In this respect it is interesting to quote Webb and Bonnet (1978) who concluded that "morning types have more satisfying and less problematic sleep and sleep the same number of hours each night compared to evening types".

Alertness ratings are seen as an indication of adjustment. Folkard et al. (1996a) have found that this rhythm adjusts best for a permanent shift system.

The alertness scores provide evidence for the better adjustment of this group of nurses to their work routine. This should not be confused with a beneficial effect of permanent night shift work itself. As Folkard et al. (1995), using a subsample of this sample, concluded: "the ratings of the permanent night nurses were, in line with their concurrent ratings, consistently higher than those of the rotating nurses when working the night shift. In view of the biographical differences between the two groups, and the reversal of this effect in the response speed measures, it would be wrong to attribute this to a beneficial effect of permanent night shifts".

Likewise, it may be tempting to not just comment on the beneficial effect of permanent night work, but also the 'ideal' combination of nightwork and childcare. After all, in this sample, permanent night nurses with childcare responsibilities seemed to fare best. Even without considering the scientific evidence, the notion is rather strange. The women in this sample most likely present a survival population. Not enough is known yet on how they became this survival population and on what happened to the women who 'did not make it'. Much more information is needed on the actual circumstances these women are dealing with. It could well be that the more quantitative survey studies usually conducted in this area of research are limited in their strength to unravel these relations. Qualitative research methods could be needed in order to present a more complete picture. In addition, only a longitudinal study would be able to really assess the long term health effects of the choices these nurses have made.

Biological and social factors

At several points in this thesis mention has been made of explanations in terms of social or biological factors. This study shows that we have to be cautious with regard to an emphasis of one or the other, systematically related to different groups. For example, when studying women in shiftwork, social factors are more readily addressed. Also, numerous studies addressing biological issues, such as the circadian rhythm research, have concentrated on men (often for practical reasons). These results are frequently generalised to both men and women in shiftwork. Monk et al. (1996) have shown in more fundamental chronobiological studies that these generalisations may well be gender-biased and that women and men age differently in chronobiological terms. And although based on survey data, the results presented fit in with the results reported by Monk et al. With regard to the alertness rhythm, it was found that older permanent night nurses had higher alertness scores compared to the younger rotating shift nurses.

In general, it appears that social factors are more likely to be considered when biological factors fail to provide adequate explanations. Still, it seems important to pay attention to both factors. Whether or not one is more important than the other may be less relevant than considering how one factor may exacerbate the effect of the other, in for example reducing alertness. Or how they may be able to counterbalance the effect of the other, e.g. where social factors, such as social interaction, may help to reduce the impact of increased sleepiness caused by biological factors.

Alertness

Alertness, as an important psychological circadian rhythm, has proven to be an interesting variable. The alertness results reported here could support possible gender differences in relation to ageing and sleep even though gender difference was not directly considered as a variable. The reported gender differences in circadian ageing (Monk et al. 1996) could explain the high alertness scores, and the fewer sleep complaints of the permanent night nurses. The findings by Monk et al. make clear that the gender discussion in relation to biological rhythms may well take a whole new turn. Monk et al. claim that the not reduced amplitude found in their study may be a characteristic of 'survivors'. This would translate rather nicely to the permanent night nurses in this sample who could be classified as survivors in a sample of survivors.

Potentially, alertness research could play an important role in crossing the bridge between the more fundamental circadian rhythm research and the survey research into the impact of shiftwork on the daily life of the worker. In future research it would be interesting to further investigate the relationship between acute and chronic effects.

Gender roles or domestic circumstances

In this study, traditional gender roles were investigated, i.e. roles that are traditionally attached to being a woman. Study constraints did not allow for a comparison between men and women. As a result, gender role differences were studied and established in a group of female nurses only. This makes the use of the word 'gender' somewhat inappropriate. What we are referring to are domestic roles and domestic responsibilities. In future research it would be recommendable to move away from the gender divide and to consider these responsibilities in terms of domestic roles, or life style or life phase. If these responsibilities are taken seriously, the implications should be the same across gender.

Variation

Finally, this study shows that there is no straightforward linear link between health problems and advancing age in shiftworking women. To date many studies have assumed linearity, e.g. the Cumulative Model (Haider et al. 1981) assumes a linear increase of problems with increased exposure. More recently, attention has focussed more on individual variation caused by individual differences (Costa 1996). For example it could well be that shiftworking women in their middle years, who are more likely to have smaller children, are more likely to report more reduced sleep duration but not necessarily more sleep difficulties. This could be the result of a moderating effect of the choices they have made and the commitment they feel towards their complicated situation. In addition, we have the situation of the younger nurses who sleep longer but who, in this study, reported more problems. It is assumed that they experience more problems as a result of their lack of commitment to adjust the two routines (social and work) to each other.

This study contradicts some of the current lines of thought in shiftwork and sleep research. Ageing was not necessarily associated with poor sleep or with resulting poor health and well-being. Also, gender and gender roles were not directly associated with poor sleep and with poor health and well-being. Thus, concluding that both older workers and women in shiftworkers are the two groups most prone to sleep problems (Scott and LaDou 1990), may well be a limited conclusion. Adjustment to shiftwork still works in mysterious ways. Rather than looking at controversies between for example men and women or the young and the elderly, diversity and individual differences need to be taken into consideration more seriously. Past research has concentrated too much on a middle of the road life style especially with regard to the health effects of shiftwork. Results have been generalised too easily and little space has been left for individual variation. It is now time to start to broaden our horizon. Allowing for more individual variation will paint a more varied and colourful picture.

REFERENCES

Åkerstedt T. 1985. Adjustment of physiological circadian rhythms and the sleep-wake cycle to shiftwork. In: S. Folkard and TH Monk (eds.). Hours of Work. Temporal factors in work-scheduling. Chichester: John Wiley and Sons.

Åkerstedt T. 1990. Psychological and psychophysiological effects of shiftwork. Scandinavian Journal of Work and Environmental Health, 16 (suppl 1), 67-73.

Åkerstedt, T. 1991. Sleepiness at work: effects of irregular work hours. In: T.H. Monk (ed.). Sleep, sleepiness, and performance. Chichester: Wiley.

Åkerstedt T and Gillberg M. 1981. Sleep disturbances and shiftwork. In: A Reinberg, N Vieux and P Andlauer (eds.). Night and Shiftwork. Biological and social aspects. Oxford: Pergamon Press.

Åkerstedt T and Torsvall L. 1981. Age, sleep, and adjustment to shiftwork. In: WP Koella (ed.). Sleep 1980: 5th European Congress on Sleep Research. Basel: Karger.

Anderson RM and Bremer DA. 1987. Sleep duration at home and sleepiness on the job in rotating twelve-hour shiftworkers. Human Factors, 29, 477-481.

Barton J. 1994. Choosing to work at night: a moderating influence on individual tolerance to shiftwork. Journal of Applied Psychology, 79, 449-454.

Barton J, Spelten ER, Smith LR, Totterdell PA and Folkard S. 1993. A classification of nursing and midwifery shift systems. International Journal of Nursing Studies, 30, 65-80.

Barton J, Spelten E, Totterdell P, Smith L, Folkard S and Costa G. 1995. The Standard Shiftwork Index: a battery of questionnaires for assessing shiftwork-related problems. Work and Stress, 9, 4-30.

Beermann B and Nachreiner F. 1995. Working shifts - different effects for men and women? Work and Stress, 9, 289-297.

Beermann B, Rutenfranz J and Nachreiner F. 1990. Gender related effects of shiftwork? An analysis of some confounding variables. In: G Costa, G Cesana, K Kogi and A Wedderburn (eds.). Shiftwork: health, sleep and performance. Frankfurt: Peter Lang.

Benoit O. 1980. Concluding remarks. In: WP Koella (ed.). Sleep 1980: 5th European Congress on Sleep Research. Basel: Karger.

Benoit O, Foret J, Bouard G, Merle J and Marc ME. 1980. Habitual sleep length and patterns of recovery after 24 hour and 36 hour sleep deprivation. Electroencephalography and Clinical Neurophysiology, 50, 477-485.

Bensing JM and Schreurs K. 1995. Sekseverschillen bij vermoeidheid [gender differences and fatigue]. Huisarts en Wetenschap, 38, 412-421.

Berry DTR and Webb WB. 1985. Mood and sleep in aging women. Journal of Personality and Social Psychology, 49, 1724-1727.

BEST No 2: Women and Nightwork. 1990. Ireland: European foundation for the improvement of living and working conditions.

Bisanti L, Olsen J, Basso O, Thonneau P, Karmaus W. 1996. Shiftwork and subfecundity: a european multicenter study. Journal of Occupational and Environmental Medicine, 38, 352-358.

Bliwise DL. 1993. Sleep in normal aging and dementia. Sleep, 16, 40-81.

Bohle P and Tilley AJ. 1989. The impact of nightwork on psychological well-being. Ergonomics, 32, 1089-1099.

Bonnet MH. 1990. Dealing with shiftwork: physical fitness, temperature, napping. Work and Stress, 4, 261-271.

Bonnet MH and Rosa RR 1987. Sleep and performance in young adults and older normals and insomniacs during acute sleep loss and recovery. Biological psychology, 153-172.

Borbély A. 1987. Secrets of sleep. Harlow: Longman Scientific and Technical.

Brendel DH, Reynolds III CF, Jennings JR, Hoch CC, Monk TH, Berman SR, Buysse DJ and Kupfer DJ. 1990. Sleep stage physiology, mood, and vigilance responses to total sleep deprivation in healthy 80-year-olds and 20-year-olds. Psychophysiology, 27, 677-685.

Brock, M.A., 1991. Chronobiology and Aging. Journal of the American Geriatric Society, 39, 74-91.

Brown D. 1982. Shiftwork, equality and women. Journal of Human Ergology, 11(Suppl), 475-482.

Buysse DJ, Monk TH, Reynolds III CF, Mesiano D, Houck PR and Kupfer DJ. 1993. Patterns of sleep episodes in young and elderly adults during a 36-hour constant routine. Sleep, 16, 632-637.

Carskadon MA and Dement WC. 1985. Sleep loss in elderly volunteers. Sleep, 8, 207-221.

Carskadon MA and Roth T. 1991. Sleep restriction. In: T.H. Monk (ed.). Sleep, sleepiness and performance. Chichester: Wiley.

Cervinka R, Haider M, Koller M and Kundi M. 1981. Psychophysiological and psychosocial studies on female shift and day workers. In: A Reinberg, N Vieux and P Andlauer (eds.). Night and Shiftwork. Biological and social aspects. Oxford: Pergamon Press.

Charles N and Brown D. 1981. Women, shiftwork and the sexual division of labour. Sociological Review, 29, 685-704.

Cohen J. 1988. Statistical power analysis for the behavioural sciences. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Colquhoun WP and Rutenfranz J. 1980. Editorial. Studies of shiftwork. London: Taylor and Francis.

Costa G. 1996. Effects on health and well-being. In: WP Colquhoun, G Costa, S Folkard and P Knauth (eds.). Shiftwork: problems and solutions. Frankfurt: Peter Lang.

Costa G and Gaffuri E. 1989. Shiftwork and housekeeping interference. G. Ital. Med Lav. 11, 113-121.

Crouter AC. 1984. Spillover from family to work: the neglected side of the work-family interface. Human Relations, 37, 425-442.

Czeisler CA, Dumont M, Duffy JF, Steinberg JD, Richardson GS, Brown EN, Sanchez R, Rios CD and Ronda JM. 1992. Association of sleep-wake habits in older people with changes in output of circadian pacemaker. The Lancet, 340, 933-936.

Dekker DK and Tepas DI. 1990. Gender differences in permanent shiftworker sleep behavior. In: G Costa, G Cesana, K Kogi and A Wedderburn (eds.). Shiftwork: health, sleep and performance. Frankfurt: Peter Lang.

Dement WC, Miles LE and Carskadon MA. 1982. "White paper" on aging. Journal of the American Geriatrics Society, 30, 25-50.

Department of Health. 1993. Night and shiftwork in nursing and midwifery. DoH: file number 195/0324.

Derogatis LR, Lipman RS and Covi MN. 1973. SCL 90 – an outpatient rating scale: preliminary report. Psychopharmacology Bulletin, 9, 13-20.

Diest R van, Milius H, Markusse R and Snel J. 1989. De slaap-waak ervaringslijst (The sleep-wake experience list). Tijdschrift voor Sociale Gezondheidszorg, 67, 343-347.

Dirken J. 1967. Work and Stress. Groningen: Wolters.

Dirkx J.1991. Recent research on night work for women: a review. In: WT Singleton and J Dirkx (eds.). Ergonomics, health and safety: perspectives for the nineties. Leuven: Leuven University Press.

Epstein R, Tzischinsky O, Chillay N and Lavie N. 1990. Rotating shift worker women in a microelectronic industry. In: G Costa, G Cesana, K Kogi and A Wedderburn (eds.). Shiftwork: health, sleep and performance. Frankfurt: Peter Lang.

Escriba V, Perez-Hoyos S and Bolumar F. 1992. Shiftwork: its impact on the length and quality of sleep among nurses of the Valencian region in Spain. International Archives of Occupational Health, 64, 125-129.

Espie CA, Lindsay WR and Espie LC. 1989. Use of the sleep assessment device (Kelley and Lichtenstein, 1980) to validate insomniacs' self-report of sleep patterns. Journal of Psychopathology and Behavioral Assessment, 11, 71-79.

Estryn-Behar M, Gadbois C, Peigne E, Masson A and Le Gall V. 1990. Impact of night shifts on male and female hospital staff. In: G Costa, G Cesana, K Kogi and A Wedderburn (eds.). Shiftwork: health, sleep and performance. Frankfurt: Peter Lang.

Eysenck SBG and Eysenck HJ. 1964. An improved short questionnaire for the measurement of extraversion and neuroticism. Life Sciences, 3, 1103-1109.

Feldberg RL and Glenn EN. 1979. Male and female: job versus gender models in the sociology of work. Social Problems, 26, 525-535.

Folkard S. 1993. Editorial. Ergonomics, 36, 1-2.

Folkard S. 1996a. Biological disruption in shiftworkers. In: WP Colquhoun, G Costa, S Folkard and P Knauth (eds.). Shiftwork: problems and solutions. Frankfurt: Peter Lang.

Folkard S. 1996b. Effects on performance efficiency. In: WP Colquhoun, G Costa, S Folkard and P Knauth (eds.). Shiftwork: problems and solutions. Frankfurt: Peter Lang.

Folkard S and Monk TH. 1985. Circadian performance rhythms. In: S. Folkard and TH Monk (eds.). Hours of Work. Temporal factors in work-scheduling. Chichester: John Wiley and Sons.

Folkard S and Åkerstedt T. 1987. Towards a model for the prediction of alertness and/or fatigue on different sleep/wake schedules. In: A Oginski, J Pokorski and J Rutenfranz (eds.). Contemporary advances in shiftwork research. Krakow: Medical Academy.

Folkard S and Åkerstedt T. 1989. Towards the prediction of alertness on abnormal sleep/wake schedules. In: A. Coblenz (ed.). Vigilance and performance in automatized systems. Dordrecht: Kluwer Academic Publishers.

Folkard S and Åkerstedt T. 1992. A 3-process model of the regulation of alertness-sleepiness. In: R.J. Broughton and B.D. Ogilvie (eds.). Sleep, arousal and performance. Boston: Birkhauser.

Folkard S and Barton J. 1993. Does the "forbidden zone" for sleep onset influence morning shift sleep duration? Ergonomics, 36, 85-91.

Folkard S, Monk TH and Lobban M. 1978. Short and long-term adjustment of circadian rhythms in "permanent" night nurses. Ergonomics, 21, 785-799.

Folkard S, Hume KI, Minors DS, Waterhouse JM and Watson FL. 1985. Independence of the circadian rhythm in alertness from the sleep/wake cycle. Nature, 313, 678-679.

Folkard S, Arendt J and Clark M. 1990. Sleep and mood on a "weekly" rotating (7-7-7) shift system: some preliminary results. In: G Costa, G Cesana, K Kogi and A Wedderburn (eds.). Shiftwork: health, sleep and performance. Frankfurt: Peter Lang.

Folkard S, Barton J, Costa G, Smith L, Spelten E, and Totterdell P. 1993. The standard shiftwork index. Ergonomics, 36, 313-314.

Folkard S, Spelten E, Totterdell P, Barton J and Smith L. 1995. The use of survey measures to assess circadian variation in alertness. Sleep, 18, 355-361.

Folkard S, Åkerstedt T, Macdonald I, Tucker P and Spencer M. 1999. Beyond the three-process model of alertness: estimating phase, time on shift, and successive night effects. Journal of Biological Rhythms (in press).

Foret J, Bensimon G, Benoit O and Vieux N. 1981. Quality of sleep as a function of age and shiftwork. In: A Reinberg, N Vieux and P Andlauer (eds.). Night and Shiftwork. Biological and social aspects. Oxford: Pergamon Press.

Frese M and Harwich C. 1984. Shiftwork and the length and quality of sleep. Journal of Occupational Medicine, 26, 561-566.

Frese M and Semmer N. 1986. Shiftwork, stress and psychosomatic complaints: a comparison between workers in different shiftwork schedules, non-shiftworkers, and former shiftworkers. Ergonomics, 29, 99-114.

Gadbois C. 1981. Women on night shift: interdependence of sleep and off the job activities. In: A Reinberg, N Vieux and P Andlauer (eds.). Night and Shiftwork. Biological and social aspects. Oxford: Pergamon Press.

Gersten AH, Duchon JC and Tepas DI. 1985. Age and gender differences in night worker's sleep lengths. In: M Haider, M Koller and R Cervinka (eds.). Night and shiftwork: long term effects and their prevention. Frankfurt: Peter Lang.

Gijsbers van Wijk CMT. 1995. Sex differences in symptom perception. Thesis. Amsterdam: University of Amsterdam.

Glazner LK. 1991. Shiftwork: its effect on workers. AAOHN Journal, 39, 416-421.

Goldberg DP. 1972. The Detection of Psychiatric Illness by Questionnaire. Oxford: Oxford University Press.

Goldberg DP Rickels K, Downing R and Hesbacher P. 1976. A comparison of two psychiatric screening tests. British Journal of Psychiatry, 129, 61-67.

Haider M, Kundi M and Koller M. 1981.Methodological issues and problems in shift work research. In: LC Johnson, DI Tepas, WP Colquhoun and MJ Colligan (eds.). Biological rhythms, sleep and shiftwork. New York: Spectrum publications.

Härmä M. 1993. Individual differences in tolerance to shiftwork: a review. Ergonomics, 36, 101-110.

Härmä M, Hakola T and Laitinen J. 1992a. Age and circadian adjustment to nightwork. Journal of Interdisciplinary Cycle Research, 23, 188-190.

Härmä M, Hakola T and Laitinen J. 1992b. Relation of age to circadian adjustment to nightwork. Scandinavian Journal of Work and Environmental Health, 18, 116-118.

Härmä, M., Knauth, P. Ilmarinen, J. and Ollila, H. 1990. The relations of age to the adjustment of the circadian rhythms of oral temperature and sleepiness to shiftwork. Chronobiology International, 7(3), 227-233

Harrington JM. 1978. Shiftwork and health. A critical review of the literature. London: HMSO.

Horne JA. 1985. Sleep loss: underlying mechanisms and tiredness. In: S. Folkard and TH Monk (eds.). Hours of Work. Temporal factors in work-scheduling. Chichester: John Wiley and Sons.

Horne JA. 1988. Sleep loss and 'divergent' thinking ability. Sleep, 11, 528-536.

Horne JA and Ostberg O. 1976. A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. International Journal of Chronobiology, 4, 97-110.

Infante-Rivard C, David M, Gauthier R and Rivard G. 1993. Pregnancy loss and work schedule during pregnancy. Epidemiology, 4, 73-75.

Johnson LC. 1992. Daytime sleepiness in good sleepers: measurement and correlates. In: RJ Broughton and RD Ogilvie (eds.). Sleep, arousal, and performance. Boston: Birkhäuser.

Johnson LC and MacLeod WL. 1973. Sleep and awake behavior during gradual sleep reduction. Perceptual and Motor Skills, 36, 87-97.

Kaye J, Kaye K and Madow L. 1983. Sleep patterns in patients with cancer and patients with cardiac disease. The Journal of Psychology, 114, 107-113.

Kecklund G, Åkerstedt T, Axelsson J and Lowden A. 1998. Sleep, alertness and performance of 'evening' and 'morning' types. Journal of Sleep Research, 7 (suppl.2), 131.

Kerkhof G. 1985. Individual differences in circadian rhythms. In: S. Folkard and TH Monk (eds.). Hours of Work. Temporal factors in work-scheduling. Chichester: John Wiley and Sons.

Knauth P and Härmä M. 1992. The relation of shiftwork tolerance to the circadian adjustment. Chronobiology International, 46-54.

Knauth P, Landau K, Droge C, Schwitteck M and Widysski M. 1980. Duration of sleep depending on the type of shiftwork. International Archives of Occupational and Environmental Health, 46, 167-177.

Knuttson A and Åkerstedt T. 1992. The healthy worker effect: self-selection among Swedish shiftworkers. Work and Stress, 6, 163-167.

Kogi K. 1985. Introduction to the problems of shiftwork. In: S. Folkard and TH Monk (eds.). Hours of Work. Temporal factors in work-scheduling. Chichester: John Wiley and Sons.

Kogi K. 1990. Women and nightwork. An introduction. In: G Costa, G Cesana, K Kogi and A Wedderburn (eds.). Shiftwork: health, sleep and performance. Frankfurt: Peter Lang.

Koller M, Kundi M, Schmidl F and Cervinka R. 1985. Physiological reactions and subjective state during night shifts as a function of age, personality, nutrition, and sleeping behaviour. In: M Haider, M Koller and Cervinka (eds.). Night and shiftwork: long term effects and their prevention. Frankfurt: Peter Lang.

Kripke DF, Simons RN, Garfinkel L and Hammond EC. 1979. Short and long sleep and sleeping pills. Archives of General Psychiatry, 36, 103-116.

Lambert S. 1990. Processes linking work and family: a critical review and research agenda. Human Relations, 43, 239-257.

Lavie P. 1986. Ultrashort sleep-waking schedule. III. "Gates" and "forbidden zones" for sleep. Electroencephalography and clinical Neurophysiology, 63, 414-425.

Lavie P. 1991. The 24-hour sleep propensity function (SPF): practical and theoretical implications. In: TH Monk (ed.). Sleep, sleepiness and performance. Chichester: John Wiley and Sons.

Lavie P, Chillag N, Epstein R, Tzischinsky O, Givon R, Fuchs S and Shahal B. 1989. Sleep disturbances in shiftworkers: a marker for maladaptation syndrome. Work and Stress, 89, 33-40.

Lee KA. 1992. Self-reported sleep disturbances in employed women. Sleep, 15, 493-498.

Loscocco KA and Rochelle AR. 1991. Influences on the quality of work and nonwork life: two decades in review. Journal of Vocational Behavior, 39, 182-225.

Mahan RP, Carvalhais AB and Queen SE. 1990. Sleep reduction in night shift workers: is it sleep deprivation or a sleep disturbance disorder? Perceptual and Motor Skills, 70, 723-730.

Mauri M. 1990. Sleep and the reproductive cycle: a review. Health Care for Women International, 11, 409-421.

Meulenbergs M and Verhaegen P. 1982. Quantitative and qualitative aspects of sleep in 50-56 years old self-selected shiftworkers. Journal of Human Ergology, 11, 457-464.

Michel-Briand C, Chopard JL, Guiot A, Paulmier M and Studer G. 1981. The pathological consequences of shiftwork in retired workers. In: A Reinberg, N Vieux and P Andlauer (eds.). Night and Shiftwork. Biological and social aspects. Oxford: Pergamon Press.

Minors DS and Waterhouse JM. 1981. Circadian Rhythms and the human. Bristol: Wright PSG.

Minors DS and Waterhouse JM. 1985. Introduction to circadian rhythms. In: S. Folkard and TH Monk (eds.). Hours of Work. Temporal factors in work-scheduling. Chichester: John Wiley and Sons.

Minors DS and Waterhouse JM. 1990. Ageing and lifestyle - implications for circadian rhythms. In E. Morgan (ed.). Chronobiology and Chronomedicine. Frankfurt: Lang.

Minors DS, Rabbitt PMA, Worthington H and Waterhouse JM. 1989. Variations in meals and sleep-activity patterns in aged subjects; its relevance to circadian rhythm studies. Chronobiology International, 6, 139-146.

Moe, K.M., Prinz, P.N., Vitiello, M.V., Marks, A.L. and Larsen, L.H. 1991. Healthy elderly women and men have different entrained circadian temperature rhythms. Journal of the American Geriatrics Society, 39, 383-387

Mojón A, Fernandez JR and Hermida RC. 1992. Chronolab: an interactive software package for chronobiologic time series analysis written for the Macintosh Computer. Chronobiology International, 9, 403-412.

Monk, TH. 1989. Circadian Rhythm. Clinics in Geriatric Medicine, 5, 331-346.

Monk TH. 1991. Sleep and circadian rhythms. Experimental Gerontology, 26, 233-243.

Monk TH and Folkard S. 1985. Individual differences in shiftwork adjustment. In: S. Folkard and TH Monk (eds.). Hours of Work. Temporal factors in work-scheduling. Chichester: John Wiley and Sons.

Monk TH and Folkard S. 1992. Making shiftwork tolerable. Chapter 7: Inter-individual differences. pp 45-50. London and Washington DC: Taylor and Francis.

Monk TH, Leng VC, Folkard S and Weitzman ED. 1983. Circadian rhythms in subjective alertness and core body temperature. Chronobiologica, 10, 49-55.

Monk TH, Buysse DJ, Reynolds III CF, Jarrett DB and Kupfer DJ. 1992a. Rhythmic vs. homeostatic influences on mood, activation, and performance in young and old men. Journal of Gerontology, 47, 221-227.

Monk TH, Reynolds III CF, Machen MA and Kupfer DJ. 1992b. Daily social rhythms in the elderly and their relation to objectively recorded sleep. Sleep, 15, 322-329.

Monk TH, Buysse DJ, Reynolds III CF, Kupfer DJ and Houck PR. 1995. Circadian temperature rhythms of older people. Experimental Gerontology, 30, 455-474.

Monk TH, Buysse DJ, Reynolds III CF, Kupfer DJ and Houck PR. 1996. Subjective alertness rhythms in elderly people. Journal of Biological Rhythms, 11, 268-276.

Moore-Ede MC, Sulzman FM and Fuller CA. 1982. The clocks that time us. Cambridge: Harvard University Press.

Moore-Ede MC and Richardson GS. 1985. Medical implications of shiftwork. Annual Review of Medicine, 36, 607-617.

Moore-Ede MC, Krieger GR and Darlington AC. 1987. Shiftwork maladaptation syndrome: etiology, diagnosis, and management. Notes, Occup Med Assoc Postgraduate Sem # 12, April 27.

Morin CM. 1993. Insomnia. Psychological assessment and management. New York: Guildford Press

Morin, CM and Grambling, S.E, 1989. Sleep patterns and aging: comparison of older adults with and without insomnia complaints. Psychology and Aging, 4, 290-294.

Morin CM Kowatch RA and Jade JB. 1989. Behavioral management of sleep disturbances secondary to chronic pain. Journal of Behavior Therapy and Experimental Psychiatry, 20, 295-302.

Naitoh P. 1976. Sleep deprivation in human subjects: A reappraisal. Waking and Sleeping, 1, 53-60.

Naitoh P. 1981. Circadian cycles and restorative powers of naps. In: LC Johnson, DI Tepas, WP Colquhoun and MJ Colligan (eds.). Biological rhythms, sleep and shiftwork. New York: Spectrum publications.

Naitoh P, Kelly TL and Englund C. 1990. Health effects of sleep deprivation. Occupational Medicine: State of the Art Reviews, 5, 209-238.

Nakazawa, Y., Nonaka, K., Nishida, N., Hayashida, N., Miyahara, Y., Kotorii, T. and Matsuoka, K. 1991. Comparison of body temperature rhythms between healthy elderly and healthy young adults. The Japanese Journal of Psychiatry and Neurology, 45, 37-43.

Neylan TC and Reynolds III CF. 1991. Pathological sleepiness. In: TH Monk (ed). Sleep, sleepiness and performance. Chichester: Wiley and Sons.

Niedhammer I, Lert F and Marne M. 1994. Effects of shiftwork on sleep among french nurses. Journal of Occupational Medicine, 36, 667-674.

Nurminen T. 1989. Shiftwork, fetal development and course of pregnancy. Scandinavian Journal of Work and Environmental Health, 15, 395-403.

Oginska H, Pokorski J and Oginski A. 1993. Gender, ageing and shiftwork intolerance. Ergonomics, 36, 161-168.

Orbell S, Crombie I and Johnston G. 1996. Social cognition and social structure in the prediction of cervical screening uptake. British Journal of Health Psychology, 1, 35-50.

Parker G. 1977. Cyclone Tracy and Darwin evacuees: on the restoration of the species. British Journal of Psychiatry, 130, 548-555.

Pastides H. 1993. A woman's work (editorial). Epidemiology, 4, 1-3.

Patkai P. 1985 The menstrual cycle. In: S. Folkard and TH Monk (eds.). Hours of Work. Temporal factors in work-scheduling. Chichester: John Wiley and Sons.

Phillips B, Magan L, Gerhardstein C and Cecil B. 1991. Shiftwork, sleep quality, and worker health: a study of police officers. Southern Medical Journal, 84, 1176-1184/1196.

Presser HB. 1986. Shiftwork among American women and childcare. Journal of Marriage and the Family, 48, 551-563.

Presser HB. 1988. Shiftwork and childcare among young dual earner American couples. Journal of Marriage and the Family, 50, 133-148.

Presser HB. 1989. Can we make time for children? The economy, work schedules and child care. Demography, 26, 523-543.

Presser HB. 1990. The growing service economy: implications for the employment of women at night. In: G Costa, G Cesana, K Kogi and A Wedderburn (eds.). Shiftwork: health, sleep and performance. Frankfurt: Peter Lang.

Rediehs MH, Reis JS and Creason NS. 1990. Sleep in old age: focus on gender differences. Sleep, 13, 410-424.

Regestein QR and Monk TH. 1991. Is the poor sleep of shiftworkers a disorder? American Journal of Psychiatry, 148, 1487-1493.

Reinberg A, Andlauer P, Guillet P, Nicolai A, Vieux N and Laporte A. 1980. Oral temperature, circadian rhythm amplitude, ageing and tolerance to shiftwork. Ergonomics, 23, 55-64.

Reinberg A, Vieux N, Andlauer P, Guillet P and Nicolai A. 1981. Tolerance to shiftwork, amplitude of circadian rhythms and aging. In: A Reinberg, N Vieux and P Andlauer (eds.). Night and Shiftwork. Biological and social aspects. Oxford: Pergamon Press.

Reinberg A, Andlauer P, Teinturier P, De Prins J, Malbecq W and Dupont J. 1983. Desynchronisation du rhythme circadien de la temperature orale chez des hommes jeunes tolerant mal le travail de nuit. Comptes Rendus des Sceances de l'Academie des Sciences - series III - Science de la Vie, 296, 267-270.

Reynolds III CF, Kupfer DJ, Taska LS, Hoch CC, Spiker DG, Sewitch DE Zimmer B, Marin RS, Nelson JP, Martin D, Morycz R. 1985. EEG sleep in elderly depressed, demented, and healthy subjects, Biological Psychiatry, 20, 431-442.

Reynolds III CF, Jennings JR, Hoch CC, Monk TH, Berman SR, Hall FT, Matzzie JV, Buysse DJ and Kupfer DJ. 1991a. Daytime sleepiness in the healthy 'old old': a comparison with young adults. Journal of the American Geriatrics Society, 39, 957-962.

Reynolds III CF, Monk TH, Hoch CC, Jennings JR, Buysse DJ, Houck PR, Jarrett DB and Kupfer DJ. 1991b. Electroencephalographic sleep in the healthy 'old old': a comparison with the 'young old' in visually scored and automated measures. Journal of Gerontology, 46, M39-M46.

Robson M and Wedderburn A. 1990. Women's shiftwork and their domestic commitments. In: G Costa, G Cesana, K Kogi and A Wedderburn (eds.). Shiftwork: health, sleep and performance. Frankfurt: Peter Lang.

Roehrs T, Timms V, Zwyghuizen-Doorenbos A, Buzenski R and Roth T. 1990. Polysomnographic, performance, and personality differences of sleepy and alert normals. Sleep, 13, 395-402.

Rosa RR. 1991. Performance, alertness, and sleep after 3.5 years of 12 h shifts: a follow-up study. Work and Stress, 5, 107-116.

Rosa RR. 1992. Napping at home and alertness on the job in rotating shiftworkers. Sleep, 16, 727-735.

Rosa RR, Bonnet MH, Bootzin RR, Eastman CI, Monk T, Penn PE, Tepas DI and Walsh JK. 1990. Intervention factors for promoting adjustment to nightwork and shiftwork. Occupational Medicine, 5, 391-416.

Rutenfranz J, Colquhoun WP, Knauth P and Ghata JN. 1977. Biomedical and psychological aspects of shiftwork. Scandinavian Journal of Work and Environmental Health, 3, 165-182.

Rutenfranz J, Haider M and Koller M. 1985. Occupational health measures for nightworkers and shiftworkers. In: S. Folkard and TH Monk (eds.). Hours of Work. Temporal factors in work-scheduling. Chichester: John Wiley and Sons.

Saito Y, Sakai K, Temmyo Y, Watanabe A and Shindo H. 1987. Attitudes of nurses towards improvement of working conditions in relation to their age and life-stage. In: A Oginski, J Pokorski and J Rutenfranz (eds.). Contemporary advances in shiftwork research. Krakow: Medical Academy.

Scott AJ and LaDou J. 1990. Shiftwork: effects on sleep and health with recommendations for medical surveillance and screening. Occupational Medicine, 5, 273-300.

Shamir B. 1983. Some antecedents of work-nonwork conflict. Journal of Vocational Behaviour, 23, 98-111.

Smith AP and Wilson M. 1990. The effects of naps during night duty on the performance and mood of female nurses working in an intensive care unit. In: G Costa, G Cesana, K Kogi and A Wedderburn (eds.). Shiftwork: health, sleep and performance. Frankfurt: Peter Lang.

Smith CS, Reilly C and Midkiff K. 1989. Evaluation of three circadian rhythm questionnaires with suggestions for an improved measure of morningness. Journal of Applied Psychology, 74, 728-738.

Spelten ER. 1988. Omgaan met onregelmatigheid [Handling irregularity: a study into coping strategies of shiftworkers]. Amsterdam: University of Amsterdam.

Spelten E, Barton J and Folkard S. 1993. Have we underestimated shiftworkers' problems? Evidence from a "reminiscence" study. Ergonomics, 36, 307-312.

Spelten E, Totterdell P, Barton J and Folkard S. 1995. Effects of age and domestic commitment on the sleep and alertness of female shiftworkers. Work and Stress, 9, 165-175.

Spence JT, Helmreich RL and Pred RS. 1987. Impatience versus achievement strivings in the Type A pattern: differential effects on students' health and academic achievement. Journal of Applied Psychology, 72, 522-528.

Taylor PJ and Pocock SJ. 1972. Mortality of shift and day workers 1956-68. British Journal of Industrial Medicine, 29, 201-207.

Tepas DI. 1982. Shiftworker sleep strategies. Journal of Human Ergology, 11, 325-336.

Tepas DI and Mahan RP. 1989. The many meanings of sleep. Work and Stress, 3, 93-102.

Tepas DI and Carvalhais AB. 1990. Sleep patterns of shiftworkers. Occupational Medicine, 5, 199-208.

Tepas DI, Walsh JK and Armstrong DR. 1981. Comprehensive study of the sleep of shiftworkers. In: LC Johnson, DI Tepas, WP Colquhoun and

MJ Colligan (eds.). Biological rhythms, sleep and shiftwork. New York: Spectrum publications.

Tepas DI, Duchon JC and Gersten AG. 1993. Shiftwork and the older worker. Experimental Aging Research, 19, 295-320.

Torsval L and Åkerstedt T. 1980. A diurnal type scale. Scandinavian Journal of Work and Environmental Health, 6, 283-290.

Totterdell P, Spelten E and Pokorski J. 1995. The effects of nightwork on psychological changes during the menstrual cycle. Journal of Advanced Nursing, 21, 996-1005.

Tune GS. 1969. The influence of age and temperament on the adult human sleep-wakefulness pattern. British Journal of Psychology, 60, 431-441.

Uehata T and Sasakawa N. 1982. The fatigue and maternity disturbances of night work women. Journal of Human Ergology, 11, 465-474.

Verhaegen P, Maasen A and Meers A. 1981. Health problems of shiftworkers. In: LC Johnson, DI Tepas, WP Colquhoun and MJ Colligan (eds.). Biological rhythms, sleep and shiftwork. New York: Spectrum publications.

Verhaegen P, Dirkx J, Maasen A and Meers A. 1985. Subjective health after twelve years of shiftwork. In: M Haider, M Koller and R Cervinka (eds.). Night and shiftwork: long term effects and their prevention. Frankfurt: Peter Lang.

Vidaceck S, Kaliterna L and Radosevic-Vidaceck B. 1987. Predictive validity of individual difference measures for health problems in shiftworkers. In: A

Oginski, J Pokorski and J Rutenfranz (eds.). Contemporary advances in shiftwork research. Krakow: Medical Academy.

Walsh JK, Tepas DI and Phyllis DM. 1981. The EEG sleep of night and rotating shiftworkers. In: LC Johnson, DI Tepas, WP Colquhoun and MJ Colligan (eds.). Biological rhythms, sleep and shiftwork. New York: Spectrum publications.

Waterhouse JM, Folkard S and Minors DS. 1990. Shiftwork, health and safety; an overview of the scientific literature 1978-1990. Report to the Health and Safety Executive.

Webb WB and Bonnet MH. 1978. The sleep of 'morning' and 'evening' types. Biological Psychology, 7, 29-35.

Webb WB and Campbell SS. 1980. Awakenings and the return to sleep in an older population. Sleep, 3, 41-46.

Webb WB, Agnew jr HW and Dreblow L. 1981. Sleep of older subjects on shiftwork. In: A Reinberg, N Vieux and P Andlauer (eds.). Night and Shiftwork. Biological and social aspects. Oxford: Pergamon Press.

Wedderburn AAI. 1995. Men and women who like continuous shiftwork are more 'hardy' but what does it mean? Work and Stress, 9, 206-210.

Wedderburn A. and Robson M. 1990. Women who work shifts: sturdy survivors or battle-weary boadiceas? Paper presented at the British Association for the Advancement of Science. Swansea.

Weitzman ED, Moline ML, Czeisler CA and Zimmerman JC. 1982. Chronobiology of aging: temperature, sleep-wake rhythms and entrainment. Neurobiology of Aging, 3, 299-309.

Wever RA. 1984. Sex differences in human circadian rhythms: intrinsic periods and sleep fractions. Experientia, 40, 1226-1234.

Wever RA. 1985 Man in temporal isolation: basic principles of the circadian system. In: S. Folkard and TH Monk (eds.). Hours of Work. Temporal factors in work-scheduling. Chichester: John Wiley and Sons.

Wilkinson RT. 1992. How fast should the night shift rotate? Ergonomics, 35, 1425-1446.

RELATED PUBLICATIONS

Barton J, Spelten E, Totterdell P, Smith L, Folkard S and Costa G. 1995. The Standard Shiftwork Index; a battery of questionnaires for assessing shiftwork-related problems. Work and Stress,9, 4-30

Barton J, Spelten E, Totterdell P, Smith L & Folkard S. 1995. Is there an optimum number of night shifts? Relationship between sleep, health and well-being. Work and Stress, 9, 109-123

Barton J, Spelten ER, Smith LR, Totterdell PA and Folkard S. 1993. A classification of nursing and midwifery shift systems. International Journal of Nursing Studies, 30, 65-80.

Barton J, Smith L, Totterdell P, Spelten E and Folkard S. 1993. Does individual choice determine shift acceptability? Ergonomics, 36, 93-99.

Folkard S, Spelten E, Totterdell P, Barton J and Smith L. 1995 The use of survey measures to assess circadian variation in alertness. Sleep, 18, 355-361.

Spelten E, Totterdell P, Barton J & Folkard S. 1995. Effects of age and domestic commitment on the sleep and alertness of female shiftworkers. Work and Stress, 9, 165-175.

Spelten E, Barton J and Folkard S. 1993. Have we underestimated shiftworkers' problems? Evidence from a 'reminiscence' study. Ergonomics, 36, 307-312.

Spelten E, Smith L, Totterdell P, Barton J, Folkard S and Bohle P. 1993. The relationship between coping strategies and GHQ-scores in nurses. Ergonomics, 36, 227-232.

Totterdell P, Spelten E and Pokorski J. 1995. The effects of nightwork on psychological changes during the menstrual cycle. Journal of Advanced Nursing, 21, 996-1005.

Totterdell P, Spelten E, Smith L, Barton J and Folkard S. 1995. Recovery from work shifts: how long does it take? Journal of Applied Psychology, 80, 43-57.

Totterdell, P, Spelten E, Barton J, Smith L & Folkard S. 1995. On-shift and daily variations in self-report and performance measures in rotating-shift and permanent night nurses. Work and Stress, 9, 187-197.

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"What cannot be avoided must be welcomed"
(William Boyd: Brazzaville Beach, 1990).

APPENDIX I:

THE SURVEY

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THE SURVEY

I.1. Data collection

The data presented in this thesis were collected as part of a larger study into the effects of shiftwork on the health and well being of nurses and midwives in England and Wales. This study was commissioned by the Department of Health and conducted over a period of three years (1990 - 1993) by the Shiftwork Research Team, based in Sheffield, of which I was a member at that time. The subject of the thesis did not form part of the commission. Use of the data set for the purpose of this thesis has been negotiated with the Research Team. The overall results of the project were reported in "Night and Shiftwork in Nursing and Midwifery"; final report on a research programme commissioned by the department of health (file number 195/0324).

The project started with a classification of shift systems in use in general hospitals in England and Wales (Barton et al. 1993). On the basis of this classification, data was collected from a random sample of nurses covering the classification criteria: flexibility of the shift system and night shift coverage. A description of the sample, including response rate information and representativity, can be found in appendix II.

Survey data collection took place in two stages. For stage one, a new questionnaire, the Standard Shiftwork Index (SSI) was developed. An extensive description of the SSI can be found in Barton et al. 1995. Below, only the sections relevant to this thesis will be discussed.

Second, nurses who volunteered to participate in further studies were sent a follow-up questionnaire, six months after completing the SSI. Sections of this questionnaire relevant to the thesis are discussed below.

I.2. Measures

I.2.1. The Standard Shiftwork Index

The Standard Shiftwork Index (SSI, Barton et al. 1995, Folkard et al. 1993) was developed for the purpose of the larger study mentioned above and contains a large number of measures which look at problems associated with working shifts. The purpose of the questionnaire in this study was to evaluate the impact of different types of shift systems, and features of shift systems, on the health and well-being of the individual nurses and midwives concerned.

The theoretical model for the SSI has been described in Barton et al. 1995, and Folkard 1993. The scales selected for the SSI can be classified under the following headings: first, 'outcomes', relating to the actual problems experienced by the individuals concerned; second 'moderators', relating to those differences between individuals which may serve to moderate the impact of shiftwork; and third 'general', including specific details of the features of the shift system, together with questions about the work context and biographical details. It should be noted that previous use of many of the standard scales has not been confined to shiftworking populations. Where standard scales were not available, new scales were constructed, though most were highly derivative of existing ones. The Standard Shiftwork Index has been included as Appendix III. The SSI measures relevant to this thesis are described below. The description is based on Barton et al. 1995.

I.2.2. Outcome measures

Sleep Quality and Disturbance Questionnaire

This questionnaire includes questions about sleep duration and sleep difficulties. The scale comprises two sections. The first is concerned with sleep habits including timing and duration of sleeps taken before and between morning, afternoon, and night shifts, and rest days, as well as the frequency and timing of naps taken in addition to the main sleep period. The second, consisting of eight items, is a measure of sleep quality and difficulties associated with each of the shifts worked, and rest days. The questionnaire consists of 6 questions, using a 5 point scale with values ranging from 1-5. A sum score for each shift and for rest days is calculated, ranging between 6 and 30. A higher score indicates more sleep difficulties. Two additional questions ask after the use of sleeping pills and alcohol.

The actual sleep times recorded in the first half of the sleep questionnaire were used to compute mean sleep duration, onset and offset times between different shifts of the same kind, and between shift changes.

For the purpose of this thesis, only the times for sleep duration between two shifts of the same kind (or two rest days) were considered.

Principal components analysis of the second half of the scale (sleep difficulties) was performed separately for the early, late and night shift, and for rest days. A fairly consistent factor structure emerged. For each shift, a distinction could be made between difficulties (quality) of sleep and behavioural strategies used to induce sleep. Because the latter comprised only two items (asking after the use of sleeping pills and alcohol), a separate subscale was not formed. Instead, the two items were treated as independent questions and were not treated as part of the six-item sleep quality scale, which thus consists of six items. A total score was computed for sleep difficulties associated with each of the shifts, ranging between 6-30, with a higher score indicating more difficulties. For this sample, coefficient alpha for the 6 items was .70 for the morning and afternoon shifts, .72 for on rest days and .79 for the night shift, indicating moderate to good internal consistency.

Chronic Fatigue

A new measure of chronic fatigue was developed. Chronic fatigue was defined as a general tiredness and lack of energy, irrespective of whether an individual has not had enough sleep or has been working hard, which persists even on rest days and holidays. The scale, which indexes this condition, consists of 10 items. Five items are positively oriented to index general feelings of vigour and energy: the opposite of chronic fatigue and are reversed scored. The other five are designed to tap general feelings of tiredness and lack of energy.

Items are scored on a 5 point scale. The 10 items are summed to one total score, ranging between 5 and 50, with a higher score indicating a higher level of chronic fatigue. The positively oriented items were reversed coded.

Factor analysis of the whole scale identified two factors, through all 10 items were found to load on both. The first accounted for a significantly greater proportion of the total variance than the second did (58.1 compared with 12.5%). The second factor appeared to reflect a response bias, with individuals responding to both negatively and positively oriented items in the same way. The analysis was therefore repeated, specifying a one-factor solution. All 10 items were subsequently found to load on a single factor. Coefficient alpha for this sample was .92, indicating good internal consistency.

General Health Questionnaire (GHQ)

The General Health Questionnaire, developed by Goldberg (1972), is a standardised, self administered screening test for detecting minor psychiatric disorders in the general population and gives a single measure of mental health (Goldberg 1972). It covers recent levels of self-confidence, depression, sleep loss and problem solving. The GHQ is available in a 60-, 30-, 20-, and 12-item version. The 12-item version was chosen for the purpose of this study. There is evidence that the GHQ correlates well with other psychiatric screening tests, such as the Symptom Checklist-90 developed by Derogatis et al. (1973) (Goldberg et al. 1976). It has also been shown to reflect the psychological effects of external events which might be expected to increase or decrease stress. Parker (1977) studied the GHQ responses of 69 survivors of a natural disaster, Cyclone Tracy, and showed that the questionnaire was sensitive to the incidence of specific psychological disorders. In addition, a recent study that used the 12-item version of the GHQ found that night work has a significant impact on psychological well-being (Bohle & Tilley 1989).

Four response options are provided for each item, which can either be scored as a 4 point scale or as a bimodal response scale. For each method of scoring a total score is computed, with a higher score indicating poorer psychological health. The 4 point method of scoring was used in the present analysis. Subjects are asked to think about their health over the past few weeks and answer the questions accordingly. Four response options are given (scored as 0,1,2 or 3) and the items are summed into one score, a higher score indicating poorer mental health. Scores range between 0 and 36.

Factor analysis of the scale resulted in two factors, though many items were found to load on both, making interpretation difficult. The analysis was therefore repeated specifying a one-factor solution. All items were subsequently found to load on a single factor. Internal consistency was good with a Cronbach's alpha of .89.

Physical Health Questionnaire

A new Physical Health Questionnaire was developed because no standardised questionnaires focused specifically on the measurement of digestive and cardiovascular health problems, which were considered the main health problems of importance to the shiftworking population. The items selected for the questionnaire were taken from existing health measures, for example

Inventory of Subjective Health (Dirken 1967) and Health Survey (Spence et al. 1987), in conjunction with discussions with colleagues specialising in gastroenterology, cardiology and occupational health problems in general.

This questionnaire consists of two subscales of 8 items each. The subscales measure cardiovascular and gastrointestinal disorders, which are both known to have a high incidence in shiftworkers. A four point scale is used. A total score for each subscale is computed by summing the individual scores. Scores range between 8 and 32 for each scale. A higher score is associated with poorer physical health.

An additional checklist of conditions and medications, as well as health behaviours and menstrual disruption, was treated as individual items and did not form part of an overall scale. Analyses for the purpose of this thesis only included the two subscales for digestive and cardiovascular problems.

Factor analysis of the digestive and cardiovascular symptoms, specifying a two-factor solution, was performed. Two distinctive factors were identified, with symptoms loading on the appropriate subscales. However, two items, one from each of the subscales, were dropped from the revised scales due to factor loadings < 0.30, resulting in two subscales with each 8 items. Internal consistency was moderate for the cardiovascular subscale (Cronbach's alpha of .71) and good for the digestive subscale (.84)

Neuroticism

One of the subscales of the Eysenck Personality Inventory (Eysenck & Eysenck 1964) was included to measure neuroticism. Mostly, it is argued that neuroticism is a personality trait and should therefore be considered as a modifier to individual tolerance rather than an outcome measure. However, longitudinal studies into shiftwork have shown that neuroticism often behaves more as an outcome measure, i.e. levels of neuroticism vary depending on the individual's experience with shiftwork (e.g. Bohle & Tilley, 1989, Verhaegen et al. 1985, Vidacek et al. 1987). On the basis of these results, neuroticism is treated as an outcome measure in this study.

The scale consists of 6 items. The response format was changed from a two-option yes/no format to a 4 point scale in order to increase the possible range of scores and to introduce more flexibility into responding. A pilot study showed that the correlations between the two formats for each item were sufficiently high for this change to be made (above 0.80). The 6 items are summed and reversed to give a total score, with a higher score indicating higher levels of neuroticism. Scores range from 6 to 24. Factor analysis showed that the items all loaded on one factor. Coefficient alpha was .65, indicating moderate internal consistency.

I.2.3. Moderators

Individual differences

Individual questions concerning age and gender, as well as experience of shiftwork, domestic situation, and the number of people, usually children, in the home who need to be looked after by the individual shiftworker were included.

Composite Morningness Questionnaire

This questionnaire is a measure of morningness, which gives an indication of preferences associated with morning or evening activities. It was developed by Smith et al. (1989) as a response to the poor, or lack of, reported psychometric properties of previous morningness questionnaires, for example Horne and Ostberg (1976) and Torsval and Åkerstedt (1980). The Composite scale was constructed by factor analysing the items from these two scales, 26 in total. Three reliable factors were identified, relating to morning activities, morning affect and eveningness. Those items that loaded highly on these factors were selected for the final scale, nine from Horne and Ostberg and four from Torsval and Åkerstedt. The psychometric properties of the new scale were good and the inter-item correlations all positive and moderate to high, ranging from +0.13 to +0.79. The coefficient alpha of the full scale was 0.87, indicating good internal consistency. For the current sample coefficient alpha was .85.

Four or five alternative responses are provided for each question. The responses vary from question to question. A total score is computed. Scores of 22 and less are classified as evening types. Scores from 23-43 as intermediate types and scores of 44 and above are classified as morning types. Higher scores are this associated with morning as opposed to evening preferences.

Factor analysis for this sample resulted in three factors being identified. These factors were almost identical to those produced by Smith et al. (1989), except for the loading of one item. Consequently the scale was not altered in order to ensure compatibility.

I.2.4. General information

Additional general questions, as opposed to scales, were included. These related to: first specific features of the shift system, for example the sequencing, timing and duration of shifts, the frequency and organisation of night work, the regularity of shift schedules and the degree of flexibility in rostering. Second, the questions related to features of the work context, including the place and type of work, job title and position in the organisation and the degree of subjective workload experienced on the different shifts worked. For this thesis, mostly general questions of the first category were relevant.

I.2.3. The Follow-Up Questionnaire

The purpose of this questionnaire was mainly to enable members of the Research Team to pursue some of their own research interests. This is reflected in the variety of measures that were included. The questionnaire is included as Appendix IV. Two measures are relevant to this thesis: alertness rating and a work-nonwork conflict scale.

Alertness ratings

In order to look at performance and mood related aspects of shiftwork, subjects were asked to give general ratings of how alert or tired they felt on a typical morning, afternoon, or night shift.

Nurses were asked to rate their alertness retrospectively. They were instructed to use the rating scales to indicate how alert or sleepy they normally felt at 2-hourly intervals before, during and after the different shifts they worked. In the case of the night shift, they were asked to consider only a second or subsequent night shift and not the first night in order to avoid differences as a result of a longer period of wakefulness prior to this shift. A nine-point rating scale was used with scores ranging from very alert (1) to very sleepy (fighting sleep, 9). For the purpose of the analyses the scores were reversed. The ratings give an overall indication of alertness on a specific shift.

Elsewhere it has been shown that these retrospective ratings compare very well to concurrent alertness ratings. These retrospective measures of alertness were shown to be sensitive to both time of day and shift, and to be valid predictors of more traditional concurrent measures of alertness, and had high level of reliability even for relatively small sample sizes (e.g. 10). Ebel's reliability coefficients for various sized subsamples of the overall groups varied around 0.97 for rotating nurses and around 0.89 for permanent night nurses (Folkard et al. 1995).

Work-Home Conflict

Respondents were asked to rate how much conflict they experienced between their work demands and their home demands. For this purpose the 6 item work-nonwork conflict rating scale developed by Shamir (1983) was included. The items are scored on a 5 point scales. The last item is reversed scored and a sum score is calculated. The total score ranges between 5 and 30. A higher score indicates more work-home conflict. The internal reliability of this scale for the follow-up sample was 0.76, indicating good internal consistency.

APPENDIX II:

THE SAMPLE

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THE SAMPLE

II.1 Questionnaire distribution and response rate

The Standard Shiftwork Index (SSI) was sent to 4000 nurses. 375 questionnaires could not be distributed and were returned. A total number of 1532 completed questionnaires were returned, giving a response rate of 42.3%. The sample spanned 101 different general hospitals throughout the 14 health regions of England, and throughout Wales. Hospitals were selected for inclusion in the study on the basis of size: 400 or more beds. Thus, with the exception of smaller hospitals, the sample can be considered representative. The number of questionnaires sent to each hospital varied, and was largely determined by the frequency with which other hospitals operated the same type of shift system. Thus if a relatively common system was in operation, fewer questionnaires were sent in order to spread the distribution across the country (Barton et al. 1995).

The follow-up Questionnaire was sent to 904 nurses who volunteered to complete more measures. Of these, 648 nurses returned completed questionnaires, giving a response rate of 72%.

II.2 Sample characteristics

In appendix I, a description of the measures used in this study was given. In this appendix, characteristics of the sample under study will be described. A number of (sub) samples will be considered. First of all the SSI sample will be discussed. Subsequently, attention will be paid separately to males and females in the sample because this is relevant to the thesis and because of the unequal numbers in both groups. Then attention will be paid to sample characteristics of permanent night nurses compared to rotating shift nurses. These were the two most important shift systems worked in the sample and analyses showed the two groups to be different on a number of important variables. Finally, similar groups will be considered for the follow-up sample, which will first be compared to the SSI sample. Please note that both sleep duration and sleep difficulties are only reported for sleeps between two shifts of the same kind. Also, if total N's do not add up to the required total, this will be due to missing data in the sample.

II.2.1 SSI sample

Sample characteristics for the SSI sample can be found in table II.1. The mean age of the nurses in the sample was 33 years (s.d. 9.5 years). The vast majority was women and two-thirds of the sample were married. Just over 60% of the nurses did not have dependants at home. On average, the nurses had worked shifts for almost 12 years (s.d. 7.4) and a small majority worked rotating shifts (57%) and not permanent night shifts (42.6%). The average number of hours worked per week was 34 (s.d. 7.2). And in the total sample, domestic reasons were not the prime motivation to work shifts. Sleep duration was shortest on night shifts (mean 6.88, s.d. 1.57) and longest on afternoon shifts (mean 9.24, s.d. 1.30). Sleep difficulties scores were highest for the night shift (mean 19.07, s.d. 5.1) and lowest for the sleeps on rest days (mean 13.12, s.d. 1.2). With regard to substance use, over 83% of the nurses reported they (almost) never used either alcohol or sleeping pills to help them to sleep after a particular shift. With the exception of the night shift (83%) well over 97 % reported (almost) never using sleeping pills on any of the shifts. For alcohol this situation was somewhat reversed. Between 83-88% reported never using alcohol to facilitate sleep on a morning, afternoon or rest day. For the night shift however this percentage was 93%.

The following shift times were worked by the vast majority of nurses: morning shift from 07:30-15:30, afternoon shift from 13:30-21:30, and night shift from 21:00-08:00. For the health and well-being variables, most scores were average.

Table II.1:
SSI sample characteristics

Variable Mean (s.d.)+	SSI-sample N= 1532	Range
Age	33.24 (9.48)	20-63
Gender N (%)	M 114 (7.5)- F 1406 (92.5)	--
Married N(%)	1017 (66.5)	--
No of dependants=0 N(%)	851 (61.2)	--
Shiftwork experience, yrs	11.80 (7.43)	--
Shift system pn/rot N(%)	591(42.6)/796(57.4)	--
Hours worked per week	34.26 (7.24)	--
Domestic reason shiftwork	2.62 (1.79)	1-5
Sleep duration, hrs:		
- morning	7.19(0.95)	--
- afternoon	9.24(1.30)	--
- night	6.88(1.57)	--
- rest day	9.15(1.21)	--
Sleep quality:		
- morning	17.96(3.83)	6-30
- afternoon	15.26 (3.51)	6-30
- night	19.07 (5.08)	6-30
- rest day	13.12 (3.62)	6-30
Cardiovascular complaints	10.24 (2.63)	8-32
Digestive complaints	13.87 (4.46)	8-32
GHQ	12.42 (5.30)	0-36
Morningness	34.42 (6.36)	13-55
Neuroticism	13.00 (3.05)	6-24
Chronic Fatigue	25.00 (7.54)	5-50
Sleep need	7.76 (1.07)	--

+unless indicated otherwise

II.2.2 Gender

Next, a comparison between the men and women in the sample was made. Table II.2 shows that very few significant differences between the two groups were found. It needs, however, to be kept in mind that the numbers in both groups differ substantially. The following differences were found. Men worked more hours per week and were less likely to have chosen shiftwork on domestic grounds. Men slept less on a morning shift and reported better sleep quality on a night shift.

Table II.2:
Comparison between men and women

Variable Mean (s.d.)+	Men N=114	Women N=1406	Significant difference
Age	33.43(8.79)	33.20(9.53)	
Married N(%)	73(64%)	934(66.5%)	
No of dependants=0	65(65%)	778(60.8)	
Shiftwork experience, yrs	11.27(7.57)	11.84(7.42)	
Shift system pn/rot, %	pn35%/rot 65%	pn43.2%/rot56.8%	
Hours worked per week	37.67(4.57)	34.00(7.34)	t=5.19***
Domestic reason shiftwork	2.10(1.52)	2.66(1.80)	t=-3.09
Sleep duration:			
- morning	6.92(.94)	7.21(.95)	t=-2.59*
- afternoon	9.10(1.50)	9.25(1.28)	
- night	6.90(1.57)	6.88(1.58)	
- rest day	9.02(1.14)	9.16(1.22)	
Sleep quality:			
- morning	17.68(3.77)	17.96(3.82)	
- afternoon	14.96(3.02)	15.30(3.53)	
- night	17.64(4.82)	19.18(5.09)	t=-3.14**
- rest day	12.89(3.45)	13.14(3.63)	
Cardiovascular complaints	9.91(2.55)	10.27(2.64)	
Digestive complaints	13.15(4.35)	13.94(4.48)	
GHQ	11.70(5.17)	12.48(5.31)	
Morningness	34.83(6.35)	34.40(6.36)	
Neuroticism	12.48(2.81)	13.04(3.08)	
Chronic Fatigue	24.13(7.01)	25.07(7.58)	
Sleep need	7.58 (1.1)	7.78 (1.1)	

significant difference: * p <= 0.05 ** p <= 0.01 *** p<= 0.001
+unless indicated otherwise

II.2.3 Shift system

Because the nurses in the sample worked two major shift systems, comparison was made between the two groups. The results can be found in table II.3. The table shows that permanent night nurses differ significantly from rotating shift nurses on almost all variables. Permanent night nurses were older, more likely to be married/living with someone, more likely to have dependants and much more likely to have chosen shiftwork because of their domestic commitment. They had been working shifts longer, but worked fewer hours per week. They slept less but also reported less sleep complaints and lower chronic fatigue scores. On the whole their scores on the health related measures were lower. Their scores on neuroticism were also lower which is remarkable because increased neuroticism scores are often associated with more shiftwork experience (cf. Bohle & Tilley 1989, Verhaegen et al. 1981).

Table II.3:
Comparison of permanent night nurses (pnn) and rotating nurses (rn)

Variable Mean, (s.d.)+	PNN (N=591)	RN (N=796)	Significant difference
Age	38.56(9.41)	29.15(7.29)	t=20.88***
Gender N (%)	93.9% F	91.5% F	
Married N(%)	80.2%	57.5%	Chi=140.51***
No of dependants=0	38.4%	78.3%	Chi=221.01***
Shiftwork experience, yrs	15.47(7.98)	9.01(5.58)	t=17.51***
Hours worked per week	30.48(8.79)	36.69(4.60)	t=-16.90***
Domestic reason shiftwork	4.21(1.36)	1.61(1.18)	t=36.97***
Sleep duration			
- night	6.50(1.34)	7.12(1.65)	t=-7.16***
- rest day	8.74(1.23)	9.38(1.14)	t=-8.14***
Sleep quality:			
- night	17.58(4.31)	20.12(5.27)	t=-9.43***
- rest day	14.68(4.01)	12.48(3.22)	t=9.27***
Cardiovascular complaints	10.21(2.64)	10.24(2.62)	
Digestive complaints	13.48(4.39)	14.28(4.52)	t=-3.27**
GHQ	11.57(5.01)	12.92(5.21)	t=-4.80***
Morningness	34.31(6.61)	33.99(6.10)	
Neuroticism	12.46(3.07)	13.42(2.93)	t=-5.80***
Chronic Fatigue	24.13(7.89)	25.66(7.29)	t=-3.52***
Sleep need	7.65 (1.1)	7.87 (1.0)	t=3.59 ***

significant difference: *** p<= 0.001
+ unless indicated otherwise

II.2.4 SSI FU-sample

The sample analyses of the SSI sample, described above show most marked difference between permanent night nurses and rotating shift nurses. Because of the substantial differences between these two groups, most analyses involving the follow-up (FU)-sample was performed separately for both groups. Therefore, in comparing the SSI and FU sample, both groups will be dealt with separately.

Rotating shift nurses

On the demographic and work variables, the SSI and FU group differed only on gender and on hours worked per week. No differences were found for age, gender, marital status, number of dependants, presence of children below the age of 18, and years of experience with shiftwork.

The FU group contained slightly fewer women (88.8% versus 93.2% for the SSI group) and the nurses in this group worked on average more hours per week (37.25 (s.d. 2.64) versus 36.30 (s.d. 5.53) hours).

As can be seen from table II.4, on the health and well-being variables, the groups differed significantly on cardiovascular complaints and on sleep duration on some of the shifts. The FU group had a higher score on cardiovascular complaints and slept less on late and night shifts and on rest days.

Permanent night nurses

Here, no significant differences were found for the demographic variables. Table II.4 shows that the groups varied significantly on the following health and well-being measures: GHQ, sleep disturbance on rest days, digestive complaints, neuroticism, and morningness. The FU group had higher scores on most measures indicating more complaints. They had a lower score on morningness, indicating a tendency towards more evening types.

Table II.4:
Comparison of SSI and FU sample for
permanent night nurses and rotating nurses

Variable mean (s.d.)	Rotating nurses		Permanent night nurses	
	SSI	FU	SSI	FU
Sleep duration				
- morning	7.19(.93)	7.15(.99)	-----	-----
- afternoon	9.39(1.28)	9.18(1.25)*	-----	-----
- night	7.24(1.65)	6.95(1.64)*	6.50(1.30)	6.50(1.40)
- rest day	9.45(1.15)	9.28(1.12)*	8.80(1.29)	8.66(1.15)
Sleep quality				
- morning	17.91(3.73)	18.04(3.80)	-----	-----
- afternoon	15.35(3.43)	14.97(3.51)	-----	-----
- night	20.13(5.12)	20.09(5.49)	17.38(4.29)	17.87(4.34)
- rest day	12.54(3.26)	12.40(3.16)	14.23(3.86)	15.23(4.14)*
Cardiovascular complaints	10.06(2.48)	10.51(2.81)*	10.04(2.60)	10.47(2.68)
Digestive complaints	14.17(4.54)	14.45(4.48)	12.98(4.19)	14.19(4.58)**
GHQ	12.71(5.09)	13.22(5.36)	11.12(4.68)	12.21(5.40)**
Morningness	33.81(5.93)	34.25(6.34)	35.03(6.35)	33.31(6.85)**
Neuroticism	13.43(2.91)	13.41(2.95)	12.13(3.02)	12.93(3.10)**
Chronic Fatigue	25.60(6.92)	25.74(7.79)	23.90(7.73)	24.46(8.11)
Sleep need	7.91(1.01)	7.81(1.08)	7.57(1.14)	7.78(1.10)*

significant difference: * $p <= 0.05$ ** $p <= 0.01$

II.3. Conclusion

In this appendix, sample characteristics have been described. First, a description of the entire sample was given. Next, differences between groups within the sample were considered. With regard to gender, very few differences were found. It needs to be kept in mind that the subsample of men was very small compared to the subsample of women. More differences were found between the two groups working the two most important shift systems in this study: permanent night shifts and rotating shifts. Permanent night nurses were, on average, older, had more shiftwork experience but worked fewer hours. In addition, they were more likely to work their present shift system because of domestic commitment. On the whole, their complaint scores were lower, compared to the nurses who worked a rotating shift system. Finally, differences were found between nurses in the original sample and the nurses who had also completed the Follow-Up Questionnaire. The results showed that nurses in the FU group had significantly higher complaint scores on a number of variables. This implies that those nurses who volunteered to complete the FU questionnaire were more likely to report more problems.

APPENDIX III:

THE STANDARD SHIFTWORK INDEX

1. Your General Biographical Information

Please answer the following questions as accurately as possible. Please note that the information you give will be treated in strictest confidence.

1.1 Today's Date: ______________

1.2 Age: ______________

1.3 Sex: Female Male
(circle one)

Your Domestic Situation

1.4 Are you: *(tick one)*

(a)	Married/Living with a partner	________
(b)	Separated/Divorced	________
(c)	Widowed	________
(d)	Single	________

1.5 On average, how many hours per week does your partner work in paid employment? ________ hours

1.6 What is your partner's usual work pattern?
(tick one)

(a)	Daytime - no shifts	________
(b)	Rotating shifts with nights	________
(c)	Rotating shifts without nights	________
(d)	Permanent nights	________
(e)	Other .... *(please specify)*	________

	Extremely unsupp-ortive	Fairly unsupp-ortive	Quite indiff-erent	Fairly support-ive	Extremely support-ive
1.7 How does your partner feel about you working shifts? *(Circle one)*	1	2	3	4	5

1.8 How many persons in your household are in each of the following age groups (excluding yourself)?

(a)	0 to 5 years	________
(b)	6 to 12 years	________
(c)	13 to 18 years	________
(d)	19 to 24 years	________
(e)	25 to 60 years	________
(f)	60 years +	________

1.9 How many of these need looking after by you? ________

1.10 How long have you worked altogether? ________ years

1.11 How long have you worked in your **present** shift system? ________ years ________ months

1.12 How long **altogether** have you been working shifts? ________ years ________ months

1.13 On average, how many hours do you work each week excluding overtime? ________ hours ________ minutes

1.14 On average, how many hours **paid** overtime do you work each week? ________ hours ________ minutes

1.15 On average, how many hours unpaid overtime do you work each week, (e.g. over-run of shifts)? ________ hours ________ minutes

1.16 Do you have a second paid job in addition to your main one? *(tick one)* ________ yes ________ no

1.17 If you have taken a career break (or breaks), how long was this for in total? ________ years ________ months

Your Shift Details

1.18 For each of the shifts that **you normally work**, at what time do they start and finish? (Please use 24h time, e.g. 21:30 or clearly indicate "am" or "pm").

		START	FINISH
(a)	Morning (or early) shift	________	________
(b)	Afternoon (or late, evening or swing) shift	________	________
(c)	Half-day shift	________	________
(d)	Night shift	________	________
(e)	Other .... *(please specify)*	________	________

1.19 On average, how long does it take you to travel to and from work?

		TO WORK		FROM WORK	
(a)	Morning Shift	________	mins	________	mins
(b)	Afternoon Shift	________	mins	________	mins
(c)	Night Shift	________	mins	________	mins
(d)	Other .... *(please specify)*	________	mins	________	mins

1.20 How do you normally travel to work? *(tick one)*

(a) By public transport ________

(b) By private transport ________

(c) By a combination of public and private ________

(d) By company transport ________

(e) By foot ________

1.21 Do you ever feel unsafe when travelling to and from work on the following shifts? *(circle one for each)*

		Almost never	Quite seldom	Quite often	Almost always
(a)	Morning	1	2	3	4
(b)	Afternoon	1	2	3	4
(c)	Night	1	2	3	4
(d)	Other .... *(please specify)*	1	2	3	4

1.22 For each of the shifts that **you normally work**, on average how many successive shifts of **the same kind** do you normally work before changing to another shift or having some days off?

		NUMBER
(a)	Number of successive morning shifts	________
(b)	Number of successive afternoon shifts	________
(c)	Number of successive night shifts	________
(d)	Total number of successive shifts (of any kind) before days off	________
(e)	Other .... *(please specify)*	________

1.23 What is the maximum number of shifts of any kind you have worked **between** days off in the past month? ________

1.24 On average, how many days off in succession do you normally have? ________

1.25 In general, when changing from one type of shift to another, what type of shift is each shift or day off followed by?

(a) Morning shifts are normally followed by: ________

(b) Afternoon shifts are normally followed by: ________

(c) Night shifts are normally followed by: ________

(d) Other .... are normally followed by: ________

(e) Days off are normally followed by: ________

1.26 On average how many nights do you work per year? ________

1.27 How are these night shifts organised?
(please tick the one which best describes your night work)

(a) permanent nightshift ________
(b) a single block of night duty per year ________
(c) occasional blocks of night duty per year ________
(d) a block of nights each month ________
(e) one or two nights each week ________
(f) any other? *(please specify)* ____________________

1.28 On average how many weekends do you have off per 28 days? ________

1.29 How regular is the shift system you work?
(please tick one)

(a) **REGULAR** i.e. a fixed roster which is repeated when the cycle of shifts finishes, even if occasional variations occur to meet special requests. ________

(b) **IRREGULAR** i.e. the duty roster does not cycle or repeat in any regular manner and individual preferences are not taken into account. ________

(c) **FLEXIBLE** i.e. where the individuals concerned are consulted about their preferred duty hours before the duty roster is drawn up. ________

1.30 If your shift system is **regular**, over how many weeks does the cycle run before it is repeated? ________

	None	Not very much	A fair amount	Quite a lot	Complete
1.31 To what extent do you feel you have control over the specific shifts that you work?	1	2	3	4	5
1.32 To what extent do you feel you have control of the specific start and finish times of the shifts you work?	1	2	3	4	5

1.33 How much advance notice of your roster are you normally given?

________ weeks ________ days

1.34 For each of the following, please indicate how often you:
(please circle one number for each)

	Almost never	Rarely	Some-times	Frequ-ently	Almost always
(a) Are required to change your roster at short notice	1	2	3	4	5
(b) Swop shifts with colleagues	1	2	3	4	5
(c) Make a request to work specific shifts	1	2	3	4	5

1.35 Use the numbers 1 - 5 to rate **your** workload in comparison to the **average** workload of other people performing a similar job in other parts of your organisation:

Where: 1 = Extremely light
2 = Quite light
3 = About the same
4 = Quite heavy
5 = Extremely heavy
(Insert one number for each type of workload on each shift)

		Morning	Afternoon	Night
(a)	Physical workload	______	______	______
(b)	Mental workload	______	______	______
(c)	Time pressures	______	______	______
(d)	Emotional stress	______	______	______

1.36 What are your main reasons for working shifts?
(please circle one number for each)

		Not a reason for me		Partly a reason for me		Very much a reason for me
(a)	It is part of the job	1	2	3	4	5
(b)	It was the only job available	1	2	3	4	5
(c)	More convenient for my domestic responsibilities	1	2	3	4	5
(d)	Higher rates of pay	1	2	3	4	5
(e)	Other .... *(please give your reasons)*	1	2	3	4	5

1.37 All other things being equal, would you prefer to give up working shifts and get a day-time job without shifts?
(circle one)

Definitely not	Probably not	Maybe	Probably yes	Definitely yes
1	2	3	4	5

1.38 What are the three main advantages of your shift system for you?

(a) ____

(b) ____

(c) ____

1.39 What are the three main disadvantages of your shift system for you?

(a) ________________________________

(b) ________________________________

(c) ________________________________

1.40 Do you feel that overall the advantages of your shift system outweigh the disadvantages?

Definitely not	Probably not	May be	Probably yes	Definitely yes
1	2	3	4	5

1.41 If you were entirely free to choose the start and finish times of your shifts, what times would you choose?

		START	FINISH
(a)	Morning shift	________	________
(b)	Afternoon shift	________	________
(c)	Night shift	________	________
(d)	Other .... *(please specify)*	________	________

1.42 The following questions relate to **general job satisfaction**, and **not** to your satisfaction with your shift system. Please circle the appropriate answer for each question.

		Disagree strongly	Disagree	Disagree slightly	Neutral	Agree slightly	Agree	Agree strongly
(a)	Generally speaking, I am very satisfied with this job	1	2	3	4	5	6	7
(b)	I frequently think of quitting this job	1	2	3	4	5	6	7
(c)	I am generally satisfied with the kind of work I do in this job	1	2	3	4	5	6	7
(d)	Most people on this job are very satisfied with the job	1	2	3	4	5	6	7
(e)	People on this job often think of quitting	1	2	3	4	5	6	7

2. Your Sleep and Fatigue

2.1 At what time do you normally fall asleep and wake up at the following points within your shift system? **Please note that, depending on your shift system, some of the sleeps listed may be the same as one another. If so, please indicate this by writing "same as e"; "same as g", etc.** Please use 24h time (e.g. 22:30) or clearly indicate "am" or "pm".

		FALL ASLEEP	WAKE UP
EARLY SHIFT			
(a)	Before your first morning shift	________	________
(b)	Between two successive morning shifts	________	________
(c)	After your last morning shift	________	________
LATE SHIFT			
(d)	Before your first afternoon shift	________	________
(e)	Between two successive afternoon shifts	________	________
(f)	After your last afternoon shift	________	________
NIGHT SHIFT			
(g)	Before your first night shift	________	________
(h)	Between two successive night shifts	________	________
(i)	After your last night shift	________	________
DAY OFF			
(j)	Before your first day off	________	________
(k)	Between two successive days off	________	________
(l)	After your last day off	________	________

2.2 If you normally take a nap/naps in addition to your main sleep, either at work or at home, at what time do you take it/them?

(a) On morning shifts from ________ to ________ and from ________ to ________

(b) On afternoon shifts from ________ to ________ and from ________ to ________

(c) On night shifts from ________ to ________ and from ________ to ________

(d) On days off from ________ to ________ and from ________ to ________

2.3 How many hours sleep do you feel you usually need per day, irrespective of which shift you are on?

________ hours ________ minutes

2.4 How do you feel about the amount of sleep you normally get? *(Circle one number for each)*

		Nowhere near enough	Could do with a lot more	Could do with a bit more	Get the right amount	Get plenty
(a)	Between successive morning shifts	1	2	3	4	5
(b)	Between successive afternoon shifts	1	2	3	4	5
(c)	Between successive night shifts	1	2	3	4	5
(d)	Between successive days off	1	2	3	4	5

2.5 How well do you normally sleep? *(Circle one number for each)*

		Extremely badly	Quite badly	Moderately well	Quite well	Extremely well
(a)	Between successive morning shifts	1	2	3	4	5
(b)	Between successive afternoon shifts	1	2	3	4	5
(c)	Between successive night shifts	1	2	3	4	5
(d)	Between successive days off	1	2	3	4	5

2.6 How rested do you normally feel after sleep? *(Circle one number for each)*

		Definitely not rested	Not very rested	Moderately rested	Quite rested	Extremely rested
(a)	Between successive morning shifts	1	2	3	4	5
(b)	Between successive afternoon shifts	1	2	3	4	5
(c)	Between successive night shifts	1	2	3	4	5
(d)	Between successive days off	1	2	3	4	5

2.7 Do you ever wake up earlier than you intended? *(Circle one number for each)*

		Almost never	Rarely	Sometimes	Frequently	Almost always
(a)	Between successive morning shifts	1	2	3	4	5
(b)	Between successive afternoon shifts	1	2	3	4	5
(c)	Between successive night shifts	1	2	3	4	5
(d)	Between successive days off	1	2	3	4	5

2.8 Do you have difficulty in falling asleep? *(Circle one number for each)*

		Almost never	Rarely	Some-times	Frequ-ently	Almost always
(a)	Between successive morning shifts	1	2	3	4	5
(b)	Between successive afternoon shifts	1	2	3	4	5
(c)	Between successive night shifts	1	2	3	4	5
(d)	Between successive days off	1	2	3	4	5

2.9 Do you take sleeping pills? *(Circle one number for each)*

		Almost never	Rarely	Some-times	Frequ-ently	Almost always
(a)	Between successive morning shifts	1	2	3	4	5
(b)	Between successive afternoon shifts	1	2	3	4	5
(c)	Between successive night shifts	1	2	3	4	5
(d)	Between successive days off	1	2	3	4	5

2.10 Do you use alcohol to help you to sleep? *(Circle one number for each)*

		Almost never	Rarely	Some-times	Frequ-ently	Almost always
(a)	Between successive morning shifts	1	2	3	4	5
(b)	Between successive afternoon shifts	1	2	3	4	5
(c)	Between successive night shifts	1	2	3	4	5
(d)	Between successive days off	1	2	3	4	5

2.11 Do you ever feel tired on: *(Circle one number for each)*

		Almost never	Rarely	Some-times	Frequ-ently	Almost always
(a)	Morning shifts	1	2	3	4	5
(b)	Afternoon shifts	1	2	3	4	5
(c)	Night shifts	1	2	3	4	5
(d)	Days off	1	2	3	4	5

2.12 The following items relate to how tired or energetic **you generally feel**, irrespective of whether you have had enough sleep or have been working very hard. Some people appear to "suffer" from permanent tiredness, even on rest days and holidays, while others seem to have limitless energy. Please indicate the degree to which the following statements apply to your own normal feelings. *(Circle one number for each).*

		Not at all		Some-what		Very much so
(a)	I generally feel I have plenty of energy	1	2	3	4	5
(b)	I usually feel drained	1	2	3	4	5
(c)	I generally feel quite active	1	2	3	4	5
(d)	I feel tired most of the time	1	2	3	4	5
(e)	I generally feel full of vigour	1	2	3	4	5
(f)	I usually feel rather lethargic	1	2	3	4	5
(g)	I generally feel alert	1	2	3	4	5
(h)	I often feel exhausted	1	2	3	4	5
(i)	I usually feel lively	1	2	3	4	5
(j)	I feel weary much of the time	1	2	3	4	5

2.13 Do you have any other comments or observations relating to your sleep and fatigue that have not been covered in the above section? If so, please try to describe them here:-

....

....

....

....

....

....

....

....

....

....

....

....

....

3. Your Health and Well-Being

3.1 Please indicate how frequently you experience the following, by circling the appropriate number:

		Almost never	Quite seldom	Quite often	Almost always
(a)	How often is your appetite disturbed?	1	2	3	4
(b)	How often do you have to watch what you eat to avoid stomach upsets?	1	2	3	4
(c)	How often do you feel nauseous?	1	2	3	4
(d)	How often do you suffer from heartburn or stomach-ache?	1	2	3	4
(e)	How often do you complain of digestion difficulties?	1	2	3	4
(f)	How often do you suffer from bloated stomach or flatulence?	1	2	3	4
(g)	How often do you suffer from pain in your abdomen?	1	2	3	4
(h)	How often do you suffer from constipation or diarrhoea?	1	2	3	4
(i)	How often do you suffer from heart palpitations?	1	2	3	4
(j)	How often do you suffer from aches and pains in your chest?	1	2	3	4
(k)	How often do you suffer from dizziness?	1	2	3	4
(l)	How often do you suffer from sudden rushes of blood to your head?	1	2	3	4
(m)	Do you suffer from shortness of breath when climbing the stairs normally?	1	2	3	4
(n)	How often have you been told that you have high blood pressure?	1	2	3	4
(o)	Have you ever been aware of your heart beating irregularly?	1	2	3	4
(p)	Do you suffer from swollen feet?	1	2	3	4
(q)	How often do you feel "tight" in your chest?	1	2	3	4
(r)	Do you feel you have put on too much weight since beginning shiftwork?	1	2	3	4
(s)	Do you feel you have lost too much weight since beginning shiftwork?	1	2	3	4

3.2 Have you suffered from any of the following (diagnosed by your doctor)?

		Before starting shiftwork	Since starting shiftwork	Never
(a)	Chronic back pain	....	....	....
(b)	Gastritis, duodenitis	....	....	....
(c)	Gastric or duodenal ulcer	....	....	....
(d)	Gall stones	....	....	....
(e)	Colitis	....	....	....
(f)	Sinusitis, tonsillitis	....	....	....
(g)	Bronchial asthma	....	....	....
(h)	Angina	....	....	....
(i)	Severe heart attack (myocardial infarction)	....	....	....
(j)	High blood pressure	....	....	....
(k)	Cardiac arrhythmias	....	....	....
(l)	Hypercholesterolaemia	....	....	....
(m)	Diabetes	....	....	....
(n)	Cystitis	....	....	....
(o)	Kidney stones	....	....	....
(p)	Eczema	....	....	....
(q)	Chronic anxiety	....	....	....
(r)	Depression	....	....	....
(s)	Arthritis	....	....	....
(t)	Haemorrhoids	....	....	....
(u)	Varicose veins	....	....	....
(v)	Anaemia	....	....	....
(w)	Headaches	....	....	....
(x)	Others	....	....	....
	....	....	....	....

3.3 Have you taken any of the following medications for prolonged periods (more than three months)?

		Before starting shiftwork	Since starting shifwork	Never
(a)	Tranquillizers	....	....	....
(b)	Sleeping tablets	....	....	....
(c)	Anti-depressants	....	....	....
(d)	Antacids	....	....	....
(e)	Antispasmodics	....	....	....
(f)	Laxatives	....	....	....

		Before starting shiftwork	Since starting shifwork	Never
(g)	Drugs to control high blood pressure	....	....	....
(h)	Diuretics	....	....	....
(i)	Heart medicines	....	....	....
(j)	Vasodilators	....	....	....
(k)	Bronchodilators	....	....	....
(l)	Vitamins, tonics	....	....	....
(m)	Pain killers	....	....	....
(n)	Steroids	....	....	....
(o)	Anti-inflammatory medicines	....	....	....
(p)	Hormones (except contraceptive pills)	....	....	....
(q)	Others	....	....	....
	....	....	....	....

		Before starting shiftwork	Since starting shiftwork
3.4	On average, how many cigarettes have you smoked per week?	....	....
3.5	On average, how many units of alcohol have you drunk per week? (e.g. 1 unit = 1/2 pint lager/ bitter or 1 glass of wine or 1 measure of spirit)	....	....
3.6	On average, how many cups of caffeinated coffee/ tea/cola have you drunk each day?	....	....

3.7 If appropriate, and you are not taking a birth control pill, has your menstrual cycle been:

		Extremely irregular	Fairly irregular	Fairly regular	Extremely regular
(a)	Before starting shiftwork	1	2	3	4
(b)	Since starting shiftwork	1	2	3	4

3.8 The following questions deal with **how you have felt in general over the past few weeks.** Please circle the most appropriate answer for each question. Remember to concentrate on present and recent complaints, not those that you have had in the distant past.

Have you recently:

(a)	been able to concentrate on what you are doing?	Better than usual	Same as usual	Less than usual	Much less than usual
(b)	lost much sleep over worry?	Not at all	No more than usual	Rather more than usual	Much more than usual
(c)	felt that you are playing a useful part in things?	More so than usual	Same as usual	Less than usual	Much less than usual
(d)	felt capable of making decisions about things?	More so than usual	Same as usual	Less than usual	Much less than usual
(e)	felt constantly under strain?	Not at all	No more than usual	Rather more than usual	Much more than usual
(f)	felt you could not overcome your difficulties?	Not at all	No more than usual	Rather more than usual	Much more than usual
(g)	been able to enjoy your normal day to day activities?	More so than usual	Same as usual	Less than usual	Much less than usual
(h)	been able to face up to your problems?	More so than usual	Same as usual	Less than usual	Much less than usual
(i)	been feeling unhappy and depressed?	Not at all	No more than usual	Rather more than usual	Much more than usual
(j)	been losing confidence in yourself?	Not at all	No more than usual	Rather more than usual	Much more than usual
(k)	been thinking of yourself as a worthless person?	Not at all	No more than usual	Rather more than usual	Much more than usual
(l)	been feeling reasonably happy all things considered?	More so than usual	About the same	Less so than usual	Much less than usual

3.9 Below are listed some descriptions of **symptoms of anxiety.**

Please indicate the degree to which you **generally** or **typically** experience the symptom **when you are feeling anxious.**

		Not at all		Some-what		Very much so
(a)	I perspire	1	2	3	4	5
(b)	My heart beats faster	1	2	3	4	5
(c)	I worry too much over something that doesn't really matter	1	2	3	4	5
(d)	I feel jittery in my body	1	2	2	4	5
(e)	I imagine terrifying scenes	1	2	3	4	5
(f)	I get diarrhoea	1	2	3	4	5
(g)	I can't keep anxiety provoking pictures out of my mind	1	2	3	4	5
(h)	I feel tense in my stomach	1	2	3	4	5
(i)	Some unimportant thought runs through my mind and bothers me	1	2	3	4	5
(j)	I nervously pace	1	2	3	4	5
(k)	I feel like I am losing out on things because I can't make up my mind soon enough	1	2	3	4	5
(l)	I feel physically immobilised	1	2	3	4	5
(m)	I can't keep anxiety provoking thoughts out of my mind	1	2	3	4	5
(n)	I find it difficult to concentrate because of uncontrollable thoughts	1	2	3	4	5

4. Your Social and Domestic Situation

4.1 Are you satisfied with the amount of time your shift system leaves you for:

		Not at all		Some-what		Very much
(a)	individual hobbies and/or sport activities	1	2	3	4	5
(b)	group/team hobbies or sport activities	1	2	3	4	5
(c)	your partner	1	2	3	4	5
(d)	your close family	1	2	3	4	5
(e)	friends and relations	1	2	3	4	5
(f)	cultural events (cinema, theatre, concert) /evenings out	1	2	3	4	5
(g)	joining social organisations	1	2	3	4	5
(h)	adult education classes	1	2	3	4	5
(i)	your children	1	2	3	4	5
(j)	going to bank or post office	1	2	3	4	5
(k)	going to dentist/doctor/chemist	1	2	3	4	5
(l)	having a tradesman do some work on your house	1	2	3	4	5
(m)	shopping (daily goods)	1	2	3	4	5
(n)	shopping (clothes, furniture, etc)	1	2	3	4	5
(o)	week-end outings	1	2	3	4	5
(p)	family outings	1	2	3	4	5
(q)	yourself	1	2	3	4	5
(r)	domestic tasks	1	2	3	4	5
(s)	religious activities	1	2	3	4	5

4.2	In general how much does your shift system interfere with the sort of things you **would like to do** in your leisure time (e.g. sport activities, hobbies, etc.)?	1	2	3	4	5
4.3	In general how much does your shift system interfere with the **domestic things you have to do** in your time off work (e.g. domestic tasks, looking after children, etc.)?	1	2	3	4	5
4.4	In general how much does your shift system interfere with the **non-domestic things you have to do** in your time off work (e.g. going to doctor, library, bank, hairdresser, etc.)?	1	2	3	4	5

4.5 Can you now please circle the letter of those items in question 4.1 (above i.e. a - s) that are of very little concern to you or that do not apply.

5. Coping

Shiftwork affects many people in a variety of ways, for example in terms of their social and domestic life. Consequently shiftworkers tend to cope with the effects of shiftwork in different ways and to different degrees. Below is a list of 8 different strategies people can use to cope with problems they experience.

In relation to the different problem areas stated below, please **indicate the extent** to which you use (or have used) **each** of the coping strategies listed.

The problem areas relate to:

your **social life**	e.g. going out, visiting friends, etc.
your **domestic life**	e.g. domestic tasks, jobs around the house, childcare, etc.
the **sleep** you get	e.g. problems falling asleep, disturbed sleep, etc.
your **job**	e.g. organisation of work, job performance, etc.

It might help to actually think of an event concerning each of the areas. For sleep an example could be: difficulty with sleeping during the day, because of light and noise.

For example, to what extent do you:

- work on solving the problems in this situation, e.g. darken room. If you don't do that at all you circle 1.
- re-organise the way you look at the situation, e.g. think that it is only three more nightshifts. If you do that quite a bit you circle 4.

		Not used	Used a little	Used some-what	Used quite a bit	Used a great deal
5.1	To what extent do you use the following strategies when you have problems with your **social life** caused by working shifts?					
(a)	I work on solving the problems in the situation	1	2	3	4	5
(b)	I re-organize the way I look at the situation, so things don't look so bad	1	2	3	4	5
(c)	I let my emotions out	1	2	3	4	5
(d)	I talk to someone about how I am feeling	1	2	3	4	5
(e)	I avoid thinking or doing anything about the situation	1	2	3	4	5
(f)	I wish the situation would go away or somehow be over with	1	2	3	4	5
(g)	I criticize myself for what is happening	1	2	3	4	5
(h)	I spend more time alone	1	2	3	4	5

		Not used	Used a little	Used somewhat	Used quite a bit	Used a great deal
5.2	To what extent do you use the following strategies when you have problems with your **domestic life** caused by working shifts?					
(a)	I work on solving the problems in the situation	1	2	3	4	5
(b)	I re-organize the way I look at the situation, so things don't look so bad	1	2	3	4	5
(c)	I let my emotions out	1	2	3	4	5
(d)	I talk to some-one about how I am feeling	1	2	3	4	5
(e)	I avoid thinking or doing anything about the situation	1	2	3	4	5
(f)	I wish the situation would go away or somehow be over with	1	2	3	4	5
(g)	I criticize myself for what is happening	1	2	3	4	5
(h)	I spend more time alone	1	2	3	4	5
5.3	To what extent do you use the following strategies when you have problems with **your sleep** caused by working shifts?					
(a)	I work on solving the problems in the situation	1	2	3	4	5
(b)	I re-organize the way I look at the situation, so things do not look so bad	1	2	3	4	5
(c)	I let my emotions out	1	2	3	4	5
(d)	I talk to some-one about how I am feeling	1	2	3	4	5
(e)	I avoid thinking or doing anything about the situation	1	2	3	4	5
(f)	I wish the situation would go away or somehow be over with	1	2	3	4	5
(g)	I criticize myself for what is happening	1	2	3	4	5
(h)	I spend more time alone	1	2	3	4	5

		Not used	Used a little	Used some-what	Used quite a bit	Used a great deal
5.4	To what extent do you use the following strategies when you have problems with the way you perform **your work** caused by working shifts?					
	(a) I work on solving the problems in the situation	1	2	3	4	5
	(b) I re-organize the way I look at the situation, so things do not look so bad	1	2	3	4	5
	(c) I let my emotions out	1	2	3	4	5
	(d) I talk to some-one about how I am feeling	1	2	3	4	5
	(e) I avoid thinking or doing anything about the situation	1	2	3	4	5
	(f) I wish the situation would go away or somehow be over with	1	2	3	4	5
	(g) I criticize myself for what is happening	1	2	3	4	5
	(h) I spend more time alone	1	2	3	4	5

5.5 In general, to what extent does working shifts cause you problems with:

	Never		Somewhat		Always
(a) sleep	1	2	3	4	5
(b) social life	1	2	3	4	5
(c) domestic life	1	2	3	4	5
(d) work performance	1	2	3	4	5

5.6 To what extent **do you think** there are **organisational** problems at your work (e.g. the way your work is organised, staffing is arranged, or management decisions are implemented)?

Not at all		Somewhat		Very much so
1	2	3	4	5

5.7 Do you find it difficult to cope with these problems?

No		Sometimes		Yes
1	2	3	4	5

6. The type of person you are

6.1 Please *tick* the response for *each* item that best describes *you.*

(a) Considering only your own "feeling best" rhythm, at what time would you get up if you were entirely free to plan your day?

- 05.00 - 06.30 a.m. ____
- 06.30 - 07.45 a.m. ____
- 07.45 - 09.45 a.m. ____
- 09.45 - 11.00 a.m. ____
- 11.00 a.m. - 12.00 (noon) ____

(b) Considering only your own "feeling best" rhythm, at what time would you go to bed if you were entirely free to plan your evening?

- 08.00 - 09.00 p.m. ____
- 09.00 - 10.15 p.m. ____
- 10.15 p.m. - 12.30 a.m. ____
- 12.30 - 01.45 a.m. ____
- 01.45 - 3.00 a.m. ____

(c) Assuming normal circumstance, how easy do you find getting up in the morning?

- Not at all easy ____
- Slightly easy ____
- Fairly easy ____
- Very easy ____

(d) How alert do you feel during the first half hour after having awakened in the morning?

- Not at all alert ____
- Slightly alert ____
- Fairly alert ____
- Very alert ____

(e) During the first half hour after having awakened in the morning, how tired do you feel?

- Very tired ____
- Fairly tired ____
- Fairly refreshed ____
- Very refreshed ____

(f) You have decided to engage in some physical exercise. A friend suggests that you do this one hour twice a week and the best time for him is 7.00 - 8.00 a.m. Bearing in mind nothing else but your own "feeling best" rhythm, how do you think you would perform?

- Would be in good form ____
- Would be in reasonable form ____
- Would find it difficult ____
- Would find it very difficult ____

(g) At what time in the evening do you feel tired and, as a result, in need of sleep?

- 08.00 - 09.00 p.m. ____
- 09.00 - 10.15 p.m. ____
- 10.15 p.m. - 12.30 a.m. ____
- 12.30 - 01.45 a.m. ____
- 01.45 - 03.00 a.m. ____

(h) You wish to be at your peak performance for a test which you know is going to be mentally exhausting and lasting for two hours. You are entirely free to plan your day, and considering only your own "feeling best" rhythm, which ONE of the four testing times would you choose?

- 08.00 - 10.00 a.m. ____
- 11.00 a.m. - 1.00 p.m. ____
- 03.00 - 05.00 p.m. ____
- 07.00 - 09.00 p.m. ____

(i)	One hears about "morning" and "evening" types of people. Which ONE of these types do you consider yourself to be?	Definitely a morning type	____
		More a morning than an evening type	____
		More an evening than a morning type	____
		Definitely an evening type	____
(j)	When would you prefer to rise (provided you have a full day's work - 8 hours) if you were totally free to arrange your time?	Before 06.30 a.m.	____
		06.30 a.m. - 07.30 a.m.	____
		07.30 - 08.30 a.m.	____
		08.30 a.m. or later	____
(k)	If you always had to rise at 06.00 a.m., what do you think it would be like?	Very difficult and unpleasant	____
		Rather difficult and unpleasant	____
		A little unpleasant but no great problem	____
		Easy and not unpleasant	____
(l)	How long a time does it usually take before you "recover your senses" in the morning after rising from a night's sleep?	0-10 minutes	____
		11-20 minutes	____
		21-40 minutes	____
		More than 40 minutes	____
(m)	Please indicate to what extent you are a morning or evening *active* individual?	Pronounced morning active (morning alert and evening tired)	____
		To some extent, morning active	____
		To some extent, evening active	____
		Pronounced evening active (morning tired and evening alert)	____

6.2 The following questions are concerned with your daily habits and preferences. Please indicate what you prefer to do, or can do, and not what you may be forced to do by your present work schedule or routine.

Please work through the questions as quickly as possible. It is your immediate reaction to the questions that we are interested in, rather than a carefully deliberated answer. There are no "right" or "wrong" answers to any of the questions. For each question we simply want you to indicate which of the five alternatives best describes you, or your preferences, by circling the appropriate number.

		Almost Never	Seldom	Sometimes	Usually	Almost Always
(a)	Do you tend to need more sleep than other people?	1	2	3	4	5
(b)	If you are feeling drowsy can you easily overcome it if you have something to do?	1	2	3	4	5
(c)	Do you find it fairly easy to get to sleep whenever you want to?	1	2	3	4	5
(d)	Can you miss out a night's sleep without too much difficulty?	1	2	3	4	5
(e)	Do you find it difficult to "wake-up" properly if you are awoken at an unusual time?	1	2	3	4	5

		Almost Never	Seldom	Some-times	Usually	Almost Always
(f)	If you had to do a certain job in the middle of the night do you think you could do it almost as easily as at a more normal time of day?	1	2	3	4	5
(g)	Do you find it easy to "sleep in" in the morning if you got to bed very late the previous night?	1	2	3	4	5
(h)	If you go to bed very late do you need to sleep in the following morning?	1	2	3	4	5
(i)	Can you easily keep alert in boring situations?	1	2	3	4	5
(j)	Are you fairly unaware as to what time it is?	1	2	3	4	5
(k)	If you are tired do you have difficulty keeping awake even though you need to?	1	2	3	4	5
(l)	Do you enjoy working at unusual times of day or night?	1	2	3	4	5
(m)	Do you feel sleepy for a while after waking in the morning?	1	2	3	4	5
(n)	Do you get up later than normal when you are on holiday?	1	2	3	4	5
(o)	If you have a lot to do can you stay up late to finish it off without feeling too tired?	1	2	3	4	5
(p)	Does the time of day have a large effect on your mood and abilities?	1	2	3	4	5
(q)	Do you find it as easy to work late at night as earlier in the day?	1	2	3	4	5
(r)	If you have to get up very early one morning do you tend to feel tired all day?	1	2	3	4	5
(s)	Do you "nod-off" if you are listening to, or watching, a boring programme?	1	2	3	4	5
(t)	Can you easily go to sleep earlier than normal to "catch up" on lost sleep, e.g. after several late nights?	1	2	3	4	5
(u)	Do you have no strong preference as to when you sleep?	1	2	3	4	5
(v)	Can you manage with only a few hours sleep each night for several days in a row without too much difficulty?	1	2	3	4	5
(w)	Do you find it fairly difficult to overcome tiredness even in a challenging situation?	1	2	3	4	5
(x)	Would you be just as happy to do something in the middle of the night as during the day?	1	2	3	4	5
(y)	Do you rely on an alarm clock, or someone else, to wake you up in the morning?	1	2	3	4	5
(z)	Do you get to sleep fairly quickly when you have gone to bed earlier than normal?	1	2	3	4	5

		Almost Never	Seldom	Some-times	Usually	Almost Always
(a')	Do you go to parties, or have evenings out with friends, if you have to get up early the following morning?	1	2	3	4	5
(b')	Do you need a cup of coffee or tea to wake up properly after you have been asleep?	1	2	3	4	5
(c')	Are there particular times of day when you would avoid doing certain jobs if you could?	1	2	3	4	5
(d')	If you could do so, would you rather wait for half-an-hour or so after waking in the morning before eating a large breakfast?	1	2	3	4	5

63 Here are some questions regarding the way you behave, feel and act. Try to decide which response option represents your usual way of acting or feeling. There are no right or wrong answers to any of the questions: your immediate reaction is what we want. Please check that you have answered all the questions. *(Circle one number for each).*

		Almost never	Quite seldom	Quite often	Almost always
(a)	Do you like plenty of excitement and bustle around you?	1	2	3	4
(b)	Does your mood go up and down?	1	2	3	4
(c)	Are you rather lively?	1	2	3	4
(d)	Do you feel 'just miserable' for no good reason?	1	2	3	4
(e)	Do you like mixing with people?	1	2	3	4
(f)	When you get annoyed do you need some-one friendly to talk to?	1	2	3	4
(g)	Would you call yourself happy-go-lucky?	1	2	3	4
(h)	Are you troubled about feelings of guilt?	1	2	3	4
(i)	Can you let yourself go and enjoy yourself a lot at a lively party?	1	2	3	4
(j)	Would you call yourself tense or 'highly strung'?	1	2	3	4
(k)	Do you like practical jokes?	1	2	3	4
(l)	Do you suffer from sleeplessness?	1	2	3	4

FOLLOW-UP STUDY

As mentioned in the introduction we will conduct several follow-up studies and may need your help for them. Can you please answer the following questions. *(please tick)*

1. Would you be willing to fill in a follow-up questionnaire:

   ________ YES ________ NO

2. Would you be willing to participate in a study that involves carrying a pocket computer with you for a couple of weeks? From time to time you will be asked to do a few simple tests on the computer.

   ________ YES ________ NO

3. If you feel that you have real problems in coping with shiftwork would you be willing to talk about this to a member of our team to help us with future research?

   ________ YES ________ NO ________ NOT APPLICABLE

If you have ticked YES to any of the above questions can you please fill in your name and address so that **we can contact you at a later date.** Again we would like to stress that all the information you give us will be treated in the **strictest confidence.**

NAME: ________________________________

ADDRESS: ________________________________

____

____

PHONE No: ________________________________

We should emphasise that it is not certain that all those indicating their willingness to help in future studies will be approached. Who we approach will depend on a number of factors, including the type of shift system they work.

APPENDIX IV:

THE FOLLOW-UP QUESTIONNAIRE

Please answer the following questions as accurately as possible. *__Please note that the information you give will be treated in strictest confidence.__*

1. Today's Date: ________________

2. **CHANGES IN YOUR SITUATION**

It is possible that some aspects of your work or your personal life have changed since you completed our first questionnaire. Please read the following questions carefully and complete those sections where changes have occurred.

2.1 Has there been a change in your **shift system:** NO / YES *(please specify)*

____ Start and finish times have changed to ________________

____

____

____ Number of successive shifts have changed to ________________

____

____

____ Shift pattern has changed to ________________

____

____

____ I have changed to rotating shifts

____ I have changed to a permanent shift ________________

____ The regularity has changed to: regular

irregular

flexible

2.2 Do you work on a different ward? NO / YES *(please specify)* ________________

2.3 Do you work with a different type of patient? NO / YES *(please specify)* ________________

2.4 Do you have a different job title? NO / YES *(please specify)* ________________

2.5 On average do you work: ____ Full time (37.5 or more hours per week)

____ Part-time (less than 37.5 hours per week)

2.6 Has your domestic situation changed? NO / YES *(please specify)*

____ Married/living with a partner

____ Separated/divorced

____ Widowed

____ Single

2.7 Has there been a change in your partner's work pattern? NO / YES *(please specify)*

____

____

2.8 Has your workload changed? NO / YES

If so, please use the numbers 1 - 5 to rate **your** workload in comparison to the **average** workload of other people performing a similar job in other parts of your organisation: *(Insert one number for each type of workload on each shift)*

Where:
1 = Extremely light
2 = Quite light
3 = About the same
4 = Quite heavy
5 = Extremely heavy

		Morning	Afternoon	Night
(a)	Physical workload	______	______	______
(b)	Mental workload	______	______	______
(c)	Time pressures	______	______	______
(d)	Emotional stress	______	______	______

3. ALERTNESS - SLEEPINESS RATINGS

Please use the scales on the following three pages to indicate how alert or sleepy you normally feel at 2-hourly intervals before, during, and after an average Morning (or Day), Afternoon and Night shift. For each type of shift, please first indicate when you normally wake up prior to it, when you start work, when you finish work, and when you normally go to sleep. In the case of the night shift please do this with respect to your second and subsequent successive night shifts rather than your first, i.e. record the time at which you normally wake up from your day sleep.

Finally, please **rate how alert or sleepy you normally feel** at 2-hourly intervals from waking up prior to, to going to sleep following, an average Morning (or Day), Afternoon, or Night shift by circling the appropriate values. The times are designed to cover the timing of all possible shifts and periods of wakefulness. **Please only make ratings for those times when you are normally awake.**

Please use 24-hour times when recording the time at which you wake-up, start work, etc (e.g. 23:30, **not** 11:30).

MORNING/EARLY (or DAY) SHIFT

Wake up at: __ : __   Start work at: __ : __

Finish work at: __ : __   Go to sleep at: __ : __

	Very Alert		Alert		Neither Alert nor Sleepy		Sleepy (but not fighting sleep)		Very Sleepy (fighting sleep)
02:00	1	2	3	4	5	6	7	8	9
04:00	1	2	3	4	5	6	7	8	9
06:00	1	2	3	4	5	6	7	8	9
08:00	1	2	3	4	5	6	7	8	9
10:00	1	2	3	4	5	6	7	8	9
12:00	1	2	3	4	5	6	7	8	9
14:00	1	2	3	4	5	6	7	8	9
16:00	1	2	3	4	5	6	7	8	9
18:00	1	2	3	4	5	6	7	8	9
20:00	1	2	3	4	5	6	7	8	9
22:00	1	2	3	4	5	6	7	8	9
24:00	1	2	3	4	5	6	7	8	9
02:00	1	2	3	4	5	6	7	8	9
04:00	1	2	3	4	5	6	7	8	9

AFTERNOON/EVENING/LATE SHIFT

Wake up at: __ __ : __ __ Start work at: __ __ : __ __

Finish work at: __ __ : __ __ Go to sleep at: __ __ : __ __

	Very Alert		Alert		Neither Alert nor Sleepy		Sleepy (but not fighting sleep)		Very Sleepy (fighting sleep)
04:00	1	2	3	4	5	6	7	8	9
06:00	1	2	3	4	5	6	7	8	9
08:00	1	2	3	4	5	6	7	8	9
10:00	1	2	3	4	5	6	7	8	9
12:00	1	2	3	4	5	6	7	8	9
14:00	1	2	3	4	5	6	7	8	9
16:00	1	2	3	4	5	6	7	8	9
18:00	1	2	3	4	5	6	7	8	9
20:00	1	2	3	4	5	6	7	8	9
22:00	1	2	3	4	5	6	7	8	9
24:00	1	2	3	4	5	6	7	8	9
02:00	1	2	3	4	5	6	7	8	9
04:00	1	2	3	4	5	6	7	8	9
06:00	1	2	3	4	5	6	7	8	9

NIGHT SHIFT

Wake up at: __ : __ Start work at: __ : __

Finish work at: __ : __ Go to sleep at: __ : __

	Very Alert		Alert		Neither Alert nor Sleepy		Sleepy (but not fighting sleep)		Very Sleepy (fighting sleep)
08:00	1	2	3	4	5	6	7	8	9
10:00	1	2	3	4	5	6	7	8	9
12:00	1	2	3	4	5	6	7	8	9
14:00	1	2	3	4	5	6	7	8	9
16:00	1	2	3	4	5	6	7	8	9
18:00	1	2	3	4	5	6	7	8	9
20:00	1	2	3	4	5	6	7	8	9
22:00	1	2	3	4	5	6	7	8	9
24:00	1	2	3	4	5	6	7	8	9
02:00	1	2	3	4	5	6	7	8	9
04:00	1	2	3	4	5	6	7	8	9
06:00	1	2	3	4	5	6	7	8	9
08:00	1	2	3	4	5	6	7	8	9
10:00	1	2	3	4	5	6	7	8	9
12:00	1	2	3	4	5	6	7	8	9
14:00	1	2	3	4	5	6	7	8	9
16:00	1	2	3	4	5	6	7	8	9
18:00	1	2	3	4	5	6	7	8	9

4. *The following questions are concerned with your daily habits and preferences. Please indicate what you prefer to do, or can do, and not what you may be forced to do by your present work schedule or routine.*

Please work through the questions as quickly as possible. It is your immediate reaction to the questions that we are interested in, rather than a carefully deliberated answer. There are no "right" or "wrong" answers to any of the questions. For each question we simply want you to indicate which of the five alternatives best describes you, or your preferences, by circling the appropriate number.

		Almost Never	**Seldom**	**Some-times**	**Usually**	**Almost Always**
(a)	Do you tend to need more sleep than other people?	1	2	3	4	5
(b)	If you are feeling drowsy can you easily overcome it if you have something to do?	1	2	3	4	5
(c)	Do you find it fairly easy to get to sleep whenever you want to?	1	2	3	4	5
(d)	Can you miss out a night's sleep without too much difficulty?	1	2	3	4	5
(e)	Do you find it difficult to "wake-up" properly if you are awoken at an unusual time?	1	2	3	4	5
(f)	If you had to do a certain job in the middle of the night do you think you could do it almost as easily as at a more normal time of day?	1	2	3	4	5
(g)	Do you find it easy to "sleep in" in the morning if you got to bed very late the previous night?	1	2	3	4	5
(h)	If you go to bed very late do you need to sleep in the following morning?	1	2	3	4	5
(i)	Can you easily keep alert in boring situations?	1	2	3	4	5
(j)	Are you fairly unaware as to what time it is?	1	2	3	4	5
(k)	If you are tired do you have difficulty keeping awake even though you need to?	1	2	3	4	5
(l)	Do you enjoy working at unusual times of day or night?	1	2	3	4	5
(m)	Do you feel sleepy for a while after waking in the morning?	1	2	3	4	5
(n)	Do you get up later than normal when you are on holiday?	1	2	3	4	5
(o)	If you have a lot to do can you stay up late to finish it off without feeling too tired?	1	2	3	4	5
(p)	Does the time of day have a large effect on your mood and abilities?	1	2	3	4	5
(q)	Do you find it as easy to work late at night as earlier in the day?	1	2	3	4	5
(r)	If you have to get up very early one morning do you tend to feel tired all day?	1	2	3	4	5

		Almost Never	Seldom	Some-times	Usually	Almost Always
(s)	Do you "nod-off" if you are listening to, or watching, a boring programme?	1	2	3	4	5
(t)	Can you easily go to sleep earlier than normal to "catch up" on lost sleep, e.g. after several late nights?	1	2	3	4	5
(u)	Do you have no strong preference as to when you sleep?	1	2	3	4	5
(v)	Can you manage with only a few hours sleep each night for several days in a row without too much difficulty?	1	2	3	4	5
(w)	Do you find it fairly difficult to overcome tiredness even in a challenging situation?	1	2	3	4	5
(x)	Would you be just as happy to do something in the middle of the night as during the day?	1	2	3	4	5
(y)	Do you rely on an alarm clock, or someone else, to wake you up in the morning?	1	2	3	4	5
(z)	Do you get to sleep fairly quickly when you have gone to bed earlier than normal?	1	2	3	4	5
(a')	Do you go to parties, or have evenings out with friends, if you have to get up early the following morning?	1	2	3	4	5
(b')	Do you need a cup of coffee or tea to wake up properly after you have been asleep?	1	2	3	4	5
(c')	Are there particular times of day when you would avoid doing certain jobs if you could?	1	2	3	4	5
(d')	If you could do so, would you rather wait for half-an-hour or so after waking in the morning before eating a large breakfast?	1	2	3	4	5

5. *The following questions deal with* <u>*how you have felt in general over the past few weeks.*</u> *Please circle the most appropriate answer for each question. Remember to concentrate on present and recent complaints, not those that you have had in the distant past.*

Have you recently:

(a)	been able to concentrate on what you are doing?	Better than usual	Same as usual	Less than usual	Much less than usual
(b)	lost much sleep over worry?	Not at all	No more than usual	Rather more than usual	Much more than usual
(c)	felt that you are playing a useful part in things?	More so than usual	Same as usual	Less than usual	Much less than usual
(d)	felt capable of making decisions about things?	More so than usual	Same as usual	Less than usual	Much less than usual
(e)	felt constantly under strain?	Not at all	No more than usual	Rather more than usual	Much more than usual

(f)	felt you could not overcome your difficulties?	Not at all	No more than usual	Rather more than usual	Much more than usual
(g)	been able to enjoy your normal day to day activities?	More so than usual	Same as usual	Less than usual	Much less than usual
(h)	been able to face up to your problems?	More so than usual	Same as usual	Less than usual	Much less than usual
(i)	been feeling unhappy and depressed?	Not at all	No more than usual	Rather more than usual	Much more than usual
(j)	been losing confidence in yourself?	Not at all	No more than usual	Rather more than usual	Much more than usual
(k)	been thinking of yourself as a worthless person?	Not at all	No more than usual	Rather more than usual	Much more than usual
(l)	been feeling reasonably happy all things considered?	More so than usual	About the same	Less so than usual	Much less than usual

6. *Different people attach different importance to the individual areas of their lives. The following questions are concerned with the importance you place on different areas in your life. The areas are as follows:*

Social life: Your activities with friends, and extended family.

Career: Your career and profession.

Family: Your immediate family.

Domestic life: Housework, house maintenance, shopping, car maintenance etc.

Sleep: Your sleep and rest.

Hobbies: Your past times e.g.. sports, knitting, reading, gardening or club activities.

Financial concerns: Maximising your income, maintaining a healthy bank balance.

Please indicate by circling the appropriate number what the relative importance of these areas is to you

		Least important						**Most important**
(a)	Social life	1	2	3	4	5	6	7
(b)	Career	1	2	3	4	5	6	7
(c)	Family	1	2	3	4	5	6	7
(d)	Domestic life	1	2	3	4	5	6	7
(e)	Sleep	1	2	3	4	5	6	7
(f)	Hobbies	1	2	3	4	5	6	7
(g)	Financial concerns	1	2	3	4	5	6	7

7.1 *Shiftwork can be a source of stress. People may deal with tension caused by working shifts in different ways. Please indicate how often you do the following kinds of things when you feel tense because of working shifts.*

		Almost never	Rarely	Some-times	Frequ-ently	Almost always
(a)	Go for a walk	1	2	3	4	5
(b)	Try to relax myself	1	2	3	4	5
(c)	Seek company of family or friends	1	2	3	4	5
(d)	Complain more to others	1	2	3	4	5
(e)	Do more physical exercise	1	2	3	4	5
(f)	Drink alcohol, use drugs or smoke more	1	2	3	4	5
(g)	Watch TV more	1	2	3	4	5
(h)	Eat or snack more	1	2	3	4	5
(i)	Take more time off from work	1	2	3	4	5
(j)	Spend money, buy something	1	2	3	4	5
(k)	Attend sporting, cultural or community events	1	2	3	4	5
(l)	Take it out on family or friends	1	2	3	4	5

7.2 **How often** does shiftwork lead you to experiencing problems with:

		Not at all		Somewhat		Very much
(a)	sleep	1	2	3	4	5
(b)	social life	1	2	3	4	5
(c)	domestic life	1	2	3	4	5
(d)	work performance	1	2	3	4	5
(e)	changing of routine	1	2	3	4	5
(f)	access to facilities e.g. shops, banks, services	1	2	3	4	5

7.3 When they occur, how **bothered/concerned** do you get about shiftwork leading you to experiencing problems with:

(a)	sleep	1	2	3	4	5
(b)	social life	1	2	3	4	5
(c)	domestic life	1	2	3	4	5
(d)	work performance	1	2	3	4	5
(e)	changing of routine	1	2	3	4	5
(f)	access to facilities e.g. shops, banks, services	1	2	3	4	5

8. *People often report different reactions to shiftwork and differences in the degree of control they have over their lives when working shifts. The following statements ask you to rate the degree of control which you believe you have over various aspects of your life when working shifts.*

Please read each statement carefully. Circle the appropriate number to indicate the extent to which you agree or disagree with each statement as it applies to you.

8.1 **GENERAL:**

		Strongly Disagree					**Strongly Agree**
(a)	When on shifts the extent to which my life is disrupted depends upon my own behaviour.	1	2	3	4	5	6
(b)	To a great extent the influence I have over my life is out of my hands when I work shifts.	1	2	3	4	5	6
(c)	When I work shifts I am unable to influence how my life is affected.	1	2	3	4	5	6
(d)	It is my own behaviour which determines the degree to which I can influence my life when on shifts.	1	2	3	4	5	6
(e)	I am in control of my life when I work shifts.	1	2	3	4	5	6
(f)	When I am on shifts being in control of what I experience is important to me.	1	2	3	4	5	6
(g)	I value the influence I have on my life when working shifts.	1	2	3	4	5	6
(h)	When I work shifts I care about being able to determine my life.	1	2	3	4	5	6
(i)	When working shifts I am concerned about being in control of my life.	1	2	3	4	5	6

8.2 **SLEEP:**

(a)	If my sleep suffers when on shifts, I am usually to blame.	1	2	3	4	5	6
(b)	The quality of sleep I get when working shifts depends largely on what I do.	1	2	3	4	5	6
(c)	When on shifts, the duration of the sleep that I get is generally beyond my control.	1	2	3	4	5	6
(d)	In relation to my shiftwork, if I am still tired when I wake up after sleeping it is my own fault.	1	2	3	4	5	6
(e)	I am responsible for how well I sleep when on shiftwork.	1	2	3	4	5	6
(f)	No matter what I do my sleep will suffer when I work shifts.	1	2	3	4	5	6
(g)	The kind of sleep I get when working shifts depends most on my own behaviour.	1	2	3	4	5	6

		Strongly Disagree					Strongly Agree
(h)	My own actions determine whether or not my sleep is disrupted when I work shifts	1	2	3	4	5	6
(i)	It is my own fault if my sleep suffers when I am working shifts.	1	2	3	4	5	6
(j)	When I work shifts I have control over the quality of sleep I get	1	2	3	4	5	6
(k)	When I work shifts getting good quality sleep is important to me	1	2	3	4	5	6
(l)	I value being able to sleep well when working shifts	1	2	3	4	5	6
(m)	When I am on shifts, I care about having adequate sleep	1	2	3	4	5	6
(n)	I am concerned about the quality of my sleep when on shifts.	1	2	3	4	5	6

8.3 **SOCIAL:**

For the following items 'social' can represent family activities and/or strictly social activities.

(a)	When on shifts there is nothing I can do about how my social life is affected.	1	2	3	4	5	6
(b)	When on shifts I am in control of how much of a social life I have.	1	2	3	4	5	6
(c)	No matter what I do my social life will be disrupted when I work shifts.	1	2	3	4	5	6
(d)	When on shifts I am unable to influence my social life.	1	2	3	4	5	6
(e)	The quality of my social life when I work shifts is largely down to what I do.	1	2	3	4	5	6
(f)	It is my own behaviour which influences the extent to which my social life is interfered with when on shifts.	1	2	3	4	5	6
(g)	When on shifts I control how much time I spend with friends, partner or family.	1	2	3	4	5	6
(h)	When working shifts I determine whether or not I have a proper social life.	1	2	3	4	5	6
(i)	If my social life is disrupted when working shifts, I am to blame.	1	2	3	4	5	6
(j)	When I work shifts, it is my own fault if my social life suffers.	1	2	3	4	5	6
(k)	I am directly responsible for the quality of my social life when I am working shifts.	1	2	3	4	5	6
(l)	When I work shifts my social life is important to me.	1	2	3	4	5	6

		Strongly Disagree					Strongly Agree
(m)	I value my time with my partner, family or friends when working shifts.	1	2	3	4	5	6
(n)	When I am on shifts I care about having a proper social and family life.	1	2	3	4	5	6
(o)	When I work shifts I am concerned about my social life	1	2	3	4	5	6

8.4 **HEALTH:**

(a)	I am directly responsible for my health when I work shifts.	1	2	3	4	5	6
(b)	No matter what I do I become unwell when working shifts.	1	2	3	4	5	6
(c)	If my health suffers when on shifts, I am usually to blame.	1	2	3	4	5	6
(d)	Any stress I feel when on shifts is generally due to my own behaviour.	1	2	3	4	5	6
(e)	Nothing I do can influence my health when working shifts.	1	2	3	4	5	6
(f)	When working shifts my well-being depends on my own actions.	1	2	3	4	5	6
(g)	I am generally unable to stop being irritable when on shifts.	1	2	3	4	5	6
(h)	I control whether or not my health is harmed when I work shifts.	1	2	3	4	5	6
(i)	When working shifts, whatever goes wrong with my health is my own fault.	1	2	3	4	5	6
(j)	My physical well-being depends on how well I take care of myself when I work shifts.	1	2	3	4	5	6
(k)	When I feel ill, when I'm working shifts, I know it is because I have not been taking care of myself properly.	1	2	3	4	5	6
(l)	If I become ill when on shifts, I have the power to make myself well again.	1	2	3	4	5	6
(m)	When I work shifts I can pretty well stay healthy by taking good care of myself	1	2	3	4	5	6
(n)	When I work shifts being in good health is important to me	1	2	3	4	5	6
(o)	I value feeling well when working shifts.	1	2	3	4	5	6
(p)	When I am on shifts I care about my well-being.	1	2	3	4	5	6
(q)	When on shifts I am concerned about my health	1	2	3	4	5	6

	Strongly Disagree					Strongly Agree

8.5 **WORK PERFORMANCE:**

(a)	In general, when I work shifts my work performance is affected no matter what I do.	1	2	3	4	5	6
(b)	When working shifts, the effectiveness of my work performance is due to my own behaviour.	1	2	3	4	5	6
(c)	When I work shifts the outcomes of my work performance are largely out of my hands.	1	2	3	4	5	6
(d)	When on shifts I can influence my job performance.	1	2	3	4	5	6
(e)	It is my own behaviour which determines my job performance when I work shifts.	1	2	3	4	5	6
(f)	When I work shifts my job effectiveness is beyond my control.	1	2	3	4	5	6
(g)	When on shifts I determine whether or not I get good results at work.	1	2	3	4	5	6
(h)	When on shifts, I am directly responsible for the quality of my work performance.	1	2	3	4	5	6
(i)	It is my own fault if my work performance suffers when I am on shifts.	1	2	3	4	5	6
(j)	Performing well at work is important to me when on shifts.	1	2	3	4	5	6
(k)	When on shifts I value being effective at work.	1	2	3	4	5	6
(l)	When I work shifts I care about my job performance.	1	2	3	4	5	6
(m)	I am concerned about performing well at work. when on shifts	1	2	3	4	5	6

8.6 **SHIFT SCHEDULE**

		Not at all				A great deal
(a)	To what extent does your shift system allow you to control the hours that you work?	1	2	3	4	5
(b)	To what extent do you organise your hours of work to take account of your own individual requirements?	1	2	3	4	5
		Not important				**Very important**
(c)	How important is it to you that you have control over the hours that you work?	1	2	3	4	5

		Not at all				Very much so
(d)	Is this control over your work hours important because you personally value being in control, i.e. have a need to feel in control generally?	1	2	3	4	5
(e)	Is this control over your work hours important because it enables you to arrange your work and non-work life?	1	2	3	4	5

(f) When you first started the shift system that you are now on, did you specifically choose, to work that system as opposed to another system? *(please tick)*   ________ YES   ________ NO

(g) If you were entirely free to choose, would you prefer to work each of these shifts on a **permanent** basis?

	Would strongly not prefer				**Would strongly prefer**
Early shift	1	2	3	4	5
Late shift	1	2	3	4	5
Night shift	1	2	3	4	5

9. *The following questions deal with the support you get in your work.*

9.1 How much can each of these people be relied on when *things get tough at work?*

		Not at all	**A little**	**Some-what**	**Very much**	
(a)	Your immediate supervisor (boss)	1	2	3	4	
(b)	Other people at work	1	2	3	4	
(c)	Your partner	1	2	3	4	No partner
(d)	Your friends and relatives	1	2	3	4	

9.2 How much is each of the following people *willing to listen to your work-related problems?*

(a)	Your immediate supervisor (boss)	1	2	3	4	
(b)	Other people at work	1	2	3	4	
(c)	Your partner	1	2	3	4	No partner
(d)	Your friends and relatives	1	2	3	4	

9.3 How much is each of the following people *helpful to you in getting your job done?*

(a)	Your immediate supervisor/boss	1	2	3	4
(b)	Other people at work	1	2	3	4

9.4 Please indicate **how true** each of the following statements is of your *immediate supervisor.*

		Not at all	A little	Some-what	Very much
(a)	My supervisor is *competent* in doing his/her job	1	2	3	4
(b)	My supervisor is very *concerned* about the welfare of those under him/her	1	2	3	4
(c)	My supervisor goes out of his/her way to *praise* good work	1	2	3	4

10. *For each of the following questions circle the number which best represents your feelings.*

		No, never						Yes, always
(a)	Do you ever have trouble organising the things you have to do?	1	2	3	4	5	6	7
(b)	Do you have a daily routine which you follow?	1	2	3	4	5	6	7
(c)	Once you have started an activity do you persist at it until you have completed it?	1	2	3	4	5	6	7
(d)	Do you plan your activities from day to day?	1	2	3	4	5	6	7
(e)	Do you find that during the day you are often not sure what to do next?	1	2	3	4	5	6	7
(f)	Do you take a long time to "get going"?	1	2	3	4	5	6	7
(g)	Do you tend to change rather aimlessly from one activity to another during the day?	1	2	3	4	5	6	7
(h)	Do you give up easily once you have started something?	1	2	3	4	5	6	7
(i)	Do you plan your activities so that they fall into a particular pattern during the day?	1	2	3	4	5	6	7
(j)	Do you have any difficulty in finishing activities once you have started them?	1	2	3	4	5	6	7

		Would have no idea						Yes definitely
(k)	Could you tell how many useful hours you put in last week?	1	2	3	4	5	6	7

		No structure at all						Very structured
(l)	Do your main activities during the day fit together in a structured way.	1	2	3	4	5	6	7

11. *For each of the following questions, circle the number which best represents your feelings.*

		Completely false		Neither true nor false		Completely true
(a)	I feel certain about how much authority I have	1	2	3	4	5
(b)	I have clear planned goals and objectives in my job	1	2	3	4	5
(c)	I have to do things that should be done differently	1	2	3	4	5
(d)	I know that I have divided my time properly	1	2	3	4	5
(e)	I receive an assignment without the staff to complete it	1	2	3	4	5
(f)	I know what my responsibilities are	1	2	3	4	5
(g)	I have to bend a rule on policy in order to carry out assignments	1	2	3	4	5
(h)	I work with two or more groups who operate quite differently	1	2	3	4	5
(i)	I know exactly what is expected of me	1	2	3	4	5
(j)	I receive incompatible (conflicting) requests from two or more people	1	2	3	4	5
(k)	I do things that are apt to be accepted by one person and not accepted by others	1	2	3	4	5
(l)	I receive an assignment without adequate resources and materials to execute it	1	2	3	4	5
(m)	Explanation is clear of what has to be done	1	2	3	4	5
(n)	I work on unnecessary things	1	2	3	4	5
(o)	One of the difficulties in my job is that I am not at home enough	1	2	3	4	5
(p)	I am often worried at work by problems that I have with my family	1	2	3	4	5
(q)	I frequently have to go to work when I am needed at home	1	2	3	4	5
(r)	My family complains that because of my job I do not devote enough time to them	1	2	3	4	5
(s)	Work often prevents me from participating in leisure activities that take place at the same time	1	2	3	4	5
(t)	My work leaves me with enough free time	1	2	3	4	5

12. *Please indicate the extent to which you have problems with your sleep when <u>changing from an afternoon shift to a morning shift.</u> If you never change from an afternoon shift to a morning shift please tick this box and turn to the next page.* ☐ not applicable

12.1 When changing from an afternoon to a morning shift at what time do you normally fall asleep and wake up? *Please use 24h time, or clearly indicate 'am' or 'pm'.*

FALL ASLEEP ________ **WAKE UP** ________

12.2 When changing from an afternoon to a morning shift how do you feel about the amount of sleep you normally get? *(Circle one number for each)*

Nowhere near enough	Could do with a lot more	Could do with a bit more	Get the right amount	Get plenty
1	2	3	4	5

12.3 When changing from an afternoon to a morning shift how well do you normally sleep? *(Circle one number for each)*

Extremely badly	Quite badly	Moderately well	Quite well	Extremely well
1	2	3	4	5

12.4 When changing from an afternoon to a morning shift how rested do you normally feel after sleep? *(Circle one number for each)*

Definitely not rested	Not very rested	Moderately rested	Quite rested	Extremely rested
1	2	3	4	5

12.5 When changing from an afternoon to a morning shift, do you: *(please circle one number for each)*

		Almost never	Rarely	Sometimes	Frequently	Almost always
(a)	wake up earlier than you intended?	1	2	3	4	5
(b)	have difficulty in falling asleep?	1	2	3	4	5
(c)	take sleeping pills	1	2	3	4	5
(d)	use alcohol to help you to sleep	1	2	3	4	5
(e)	feel tired	1	2	3	4	5

13. **The following section of this questionnaire asks questions about your menstrual cycle in relation to shiftwork. We realise that these questions are of a highly personal nature. We would like to stress again that all answers will be treated in strictest confidence and that no individual will be identified in connection with any of the research findings. (If you have any objections to filling in this section, or if it is not relevant to you, then please turn to the back page for the next question).**

13.1 Do you know the start date of your last period?

No/Yes: .... : .... 19.........

13.2 Are you at the moment: *(please tick)*

.... using a birth control pill
.... pregnant
.... menopausal
.... having normal periods (i.e. approx. every 4 weeks)
.... having abnormal periods
.... other: ....

13.3 **(a)** Duration of your menstrual cycle (from beginning of one period to beginning of next)

On average	....	days
maximum	....	days
minimum	....	days
not applicable	....	

(b) Difference between consecutive cycles (on average)

....	0-2 days
....	3-4 days
....	5-6 days
....	7 or more days

13.4 Duration of your period (days you are bleeding):

On average	....	days
maximum	....	days
minimum	....	days
not applicable	....	

13.5 **Time** of day of the start of your period

02:00 - 05:59	....
06:00 - 09:59	....
10:00 - 13:59	....
14:00 - 17:59	....
18:00 - 21:59	....
22:00 - 01:59	....
differs	....
do not know	....

		Not at all		Moderate		Very much
13.6 Do you suffer from premenstrual problems?		1	2	3	4	5
To what extent are they:	mood/psychological problems	1	2	3	4	5
	physical problems	1	2	3	4	5
		Never		**Sometimes**		**Always**
For this, how often do you take:	pain-killers	1	2	3	4	5
	tranquillisers	1	2	3	4	5
	sleeping pills	1	2	3	4	5

13.7 Duration of pre-menstrual problems .... days (on average)

		Not at all		Moderately		Very much
13.8 Do you suffer from menstrual problems?		1	2	3	4	5
To what extent are they:	mood/psychological problems	1	2	3	4	5
	physical problems	1	2	3	4	5
		Never		**Sometimes**		**Always**
For this, how often do you take:	pain-killers	1	2	3	4	5
	tranquillisers	1	2	3	4	5
	sleeping pills	1	2	3	4	5

13.9 Duration of menstrual problems .... days (on average)

13.10 Please indicate the **level of discomfort** on each of the following shifts/days off for each of the menstrual phases mentioned. In the case of a working day do also take into account your time outside work and your quality of sleep. If you do not work all the shifts mentioned, please only answer for the shifts you do work. In any case, please do not forget to fill in the day off-rating.

	No discomfort		Moderate discomfort		Extreme discomfort
PRE-MENSTRUAL					
EARLY SHIFT	1	2	3	4	5
LATE SHIFT	1	2	3	4	5
NIGHT SHIFT	1	2	3	4	5
DAY OFF	1	2	3	4	5
MENSTRUAL					
EARLY SHIFT	1	2	3	4	5
LATE SHIFT	1	2	3	4	5
NIGHT SHIFT	1	2	3	4	5
DAY OFF	1	2	3	4	5
THE REST OF A CYCLE (apart from menstruation and premenstrual phase)					
EARLY SHIFT	1	2	3	4	5
LATE SHIFT	1	2	3	4	5
NIGHT SHIFT	1	2	3	4	5
DAY OFF	1	2	3	4	5

13.11 Have you observed any change in your menstrual cycle since you started shiftwork (e.g. regularity, level of bleeding, change in symptoms - increase/decrease)

NO / YES *(please specify)* ______________________________

____

13.12 Focusing on your most problematic phase, can you indicate any variety in the severity of symptoms for each of the four seasons?

Where: 1 = less than normal
2 = a bit less than normal
3 = normal
4 = a bit more than normal
5 = more than normal

	Spring	**Summer**	**Autumn**	**Winter**
Morning	....	....	....	....
Afternoon	....	....	....	....
Night	....	....	....	....
Days off	....	....	....	....

13.13 My most problematic phase is:

.... pre-menstrual

.... menstrual

.... rest of cycle

13.14 **MISCARRIAGES DURING EMPLOYMENT**

A member of the University of Sheffield's Psychology Department, Dr Pauline Slade, is researching the impact of miscarriages on subsequent work performance and job satisfaction. **If you have had a miscarriage during your employment** and would be willing to take part in some research on this, please sign below. We cannot release your name and address to Dr Slade without your signed permission.

I agree to my name and address being released to Dr Pauline Slade.

(Signed) .... *Date / /1991*